PowerApps canvas app coding standards and guidelines

White paper

Summary: This technical white paper is aimed at Microsoft PowerApps makers in the enterprise. It contains standards for naming objects, collections, and variables, and guidelines for developing consistent, performant, and easily maintainable apps.

Writers: Todd Baginski, Pat Dunn

Technical Contributors: Mehdi Slaoui Andaloussi, Alex Belikov, Casey Burke, Ian Davis, Brian Dang, Rémi Delarboulas, Aniket J. Gaud, Nick Gill, Audrie Gordon, Erik Orum Hansen, Eric Mckinney, Santhosh Sudhakaran, Hubert Sui, Vanessa Welgemoed, Keith Whatling

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Introduction

Microsoft PowerApps is a high-productivity application development platform from Microsoft. Microsoft uses this platform to build first-party applications in Microsoft Dynamics 365 for Sales, Microsoft Dynamics 365 for Service, Microsoft Dynamics 365 for Field Service, Microsoft Dynamics 365 for Marketing, and Microsoft Dynamics 365 for Talent. Enterprise customers can also use the same platform to build their own custom line-of-business applications. Individual users and teams within your organization can also build personal or team productivity applications without having to write very much code (or any).

Purpose of this white paper

This white paper is targeted at the enterprise application maker (developer) who is responsible for designing, building, testing, deploying, and maintaining PowerApps apps in a corporate or government environment. This white paper was developed as a collaboration between the Microsoft PowerApps team, Microsoft IT, and industry professionals. Of course, enterprise customers are free to develop their own standards and practices. However, we feel that adherence to these guidelines will help developers in these areas:

- Simplicity
- Readability
- Supportability
- Ease of deployment and administration
- Performance
- Accessibility

Scope of this white paper

Except where specifically noted, all features that are mentioned in this white paper are available as of December 2018. The following topics are out of scope for this white paper:

- PowerApps fundamentals for building applications. This white paper assumes that the reader has a working knowledge, but not necessarily expert knowledge, of how to build a PowerApps app. For blogs, tutorials, training resources, and community support, visit https://docs.microsoft.com/en-us/powerapps/index.
- Microsoft Power BI and other parts of the broader Microsoft Power platform.
- Code outside PowerApps, such as code in Microsoft Azure App Service and Function App.
- General governance and Application Lifecycle Management (ALM).
- Environment administration. To learn about this topic, we recommend that you read the Administering a PowerApps enterprise deployment white paper.

This is a living document

This white paper is intended to be a living document. As Microsoft Power platform capabilities and industry standards change, so will this white paper.

Microsoft is listening to customer feedback and is constantly evolving the Power platform to help you build better apps for your users. As a result, today’s best practice might become obsolete as new features change the most efficient approaches. Check back periodically to see the latest standards and guidelines.

Thank you to all the professionals who have contributed to this white paper by sharing your collective guidance and experience. Now, on to the guidance.

General naming conventions

This section describes "camel case" and "Pascal case" naming conventions. If you're already familiar with those terms, you can skip ahead.

Camel case

You should use camel case for controls and variables. Camel case begins with a lowercase prefix, removes all spaces from object or variable names, and capitalizes the first letter of each word after the first. For example, a text input control might be named `txtUserEmailAddress`.

Pascal case

You should use Pascal case for data sources. Pascal case is sometimes referred to as "upper camel case." Like camel case, it removes all spaces and capitalizes the first letter of words. However, unlike camel case, Pascal case also capitalizes the first word. For example, a common data source in PowerApps is the Microsoft Office 365 Users connector, which is named `Office365Users` in your code.

Object naming conventions

As you create objects in your PowerApps apps, it's important to use consistent naming conventions for screens, controls, and data sources. This approach will make your apps easier to maintain, can help improve accessibility, and will make your code easier to read as those objects are referenced.

Note: As we were preparing this white paper, we found lots of variance in the naming conventions of different organizations. One experienced maker renames her controls only if they're referenced in formulas. Several makers prefer different prefixes for their controls.

This is OK! The object naming conventions in this white paper are intended as guidelines, and organizations are free to develop their own standards. The main point is to be consistent.

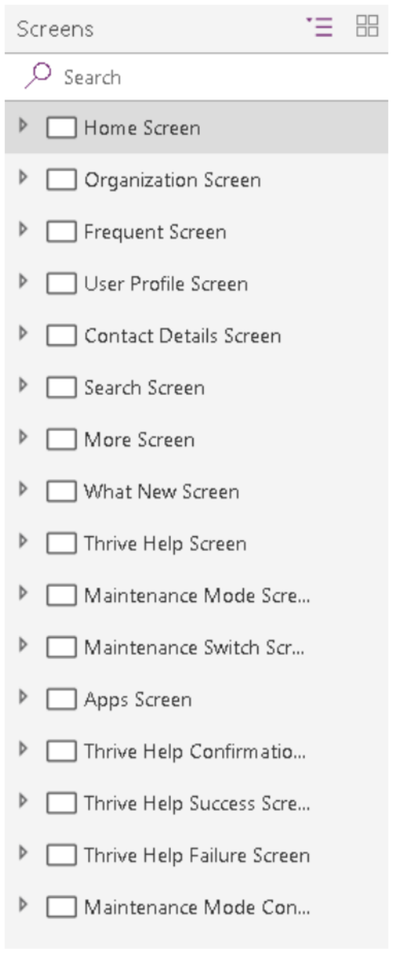
Screen names

Screen names should reflect the purpose of the screen, so that it's easier to navigate through complex apps in PowerApps Studio.

What's less obvious is that screen names are read aloud by screen readers, which are needed for users who have vision accessibility needs. Therefore, ***it's imperative that you use plain language to name your screens, and that the names include spaces and no abbreviations***. Also, *we recommend that you end the name with the word "Screen," so that the context is understood when the name is announced.*

Here are some good examples:

- `Home Screen`
- `Thrive Help Screen`



Here are some bad examples:

- `Home`
- `LoaderScreen`
- `EmpProfDetails`
- `Thrive Help`

Control names

All control names on the canvas should use camel case. They should begin with a three-character type descriptor, followed by the purpose of the control. This approach helps identify the type of control and makes it easier to build formulas and search.

Here's a good example: `lblUserName`

The following table shows the abbreviations for common controls.

Control name	**Abbreviation**
button	btn
camera control	cam
canvas	can
card	crd

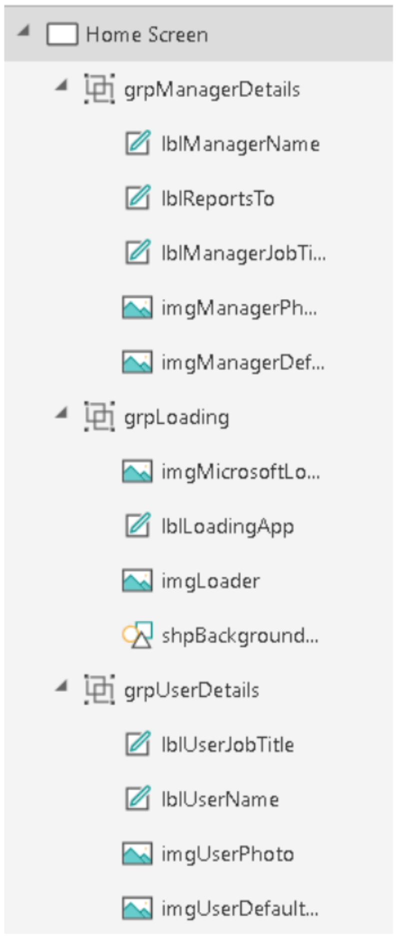
collection	col
combo box	cmb
dates	dte
drop down	drp
form	frm
gallery	gal
group	grp
header page shape	hdr
html text	htm
icon	ico
image	img
label	lbl
page section shape	sec
shapes (rectangle, circle, and so on)	shp
table data	tbl
text input	txt
timer	tim

Control names must be unique across an application. If a control is reused on multiple screens, the short screen name should be suffixed at the end – for example, `galBottomNavMenuHS`, where "HS" stands for "Home Screen." This approach makes it easier to reference the control in formulas across screens.

Here are some bad examples:

- `zipcode`
- `Next`

As the following image shows, if you consistently name your controls, your app will be much cleaner in the navigation view, and your code will be much cleaner too.



Data source names

When you add a data source to your application, the name can't be changed in the PowerApps app. The name is inherited from the source connector or data entities that are derived from the connection.

Here are some examples:

- **Name inherited from the source connector:** The Office 365 Users connector is named `Office365Users` in your code.
- **Data entities derived from the connection:** A Microsoft SharePoint list that's named **Employees** is returned from the SharePoint connector. Therefore, the name of the data source in your code is `Employees`. The same PowerApps app can also use ***the same SharePoint connector*** to access a SharePoint list that's named Contractors. In this case, the name of the data source in the code is `Contractors`.

For more information about connectors and connections, see the Overview of canvas-app connectors for PowerApps article.

Standard action connectors

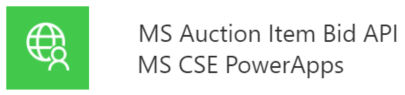
In Standard action connectors that expose functions, such as LinkedIn, you'll see that the data source name and its operations use Pascal casing (that is, `UpperUpperUpper`). For example, the LinkedIn data source is named `LinkedIn` and has an operation named `ListCompanies`.

```
ClearCollect(
    colCompanies,
    LinkedIn.ListCompanies()
)
```

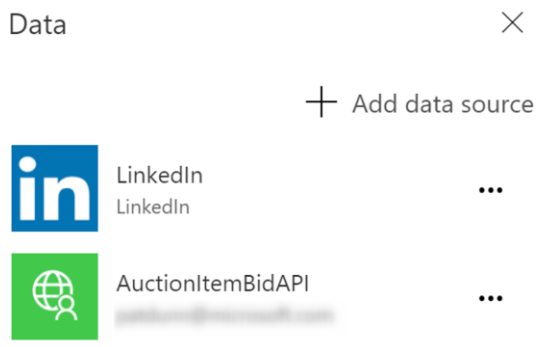
Custom connectors

Custom connectors can be created by any maker in your environment. They're used to connect to custom application programming interfaces (APIs) such as third-party services or line-of-business APIs that your IT department has created. Pascal casing is also recommended for the data source name and its operations. Just be aware that the custom connector name and the way that it appears in PowerApps can differ.

For example, here's a custom connector named **MS Auction Item Bid API**.

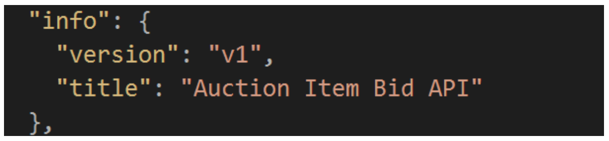

MS Auction Item Bid API
MS CSE PowerApps

But when you create a connection from this connector and add it to your PowerApps app as a data source, it appears as **AuctionItemBidAPI**.



LinkedIn
LinkedIn
AuctionItemBidAPI
[redacted]

To discover the reason, you can look inside the OpenAPI file. There, you'll see a `title` attribute that contains the text `Auction Item Bid API`.



```
"info": {
  "version": "v1",
  "title": "Auction Item Bid API"
},
```

PowerApps removes all the spaces from this attribute value and uses it as the name of your data source. We recommend that you change the value of this attribute to a Pascal-cased name such as `AuctionItemBidAPI` and use it as the name of your custom connection. In that way, there will be no confusion. Change this value before you import the OpenAPI file to create the custom connector.

Note: If you use the **Create from blank** option instead of importing an existing OpenAPI file, PowerApps will prompt you for the custom connector name. This name will be used both as the name of the custom connector and as the value of the `title` attribute inside the OpenAPI file. Once again, if you just use a Pascal-cased name such as `AuctionItemBidAPI`, you'll be fine.

Excel DataTables

PowerApps uses DataTables in Microsoft Excel to connect to data in Excel worksheets. Keep these points in mind when you create Excel documents as data sources:

- Give your DataTables descriptive names. You'll see the name in the PowerApps app when you write the code to connect to it.
- Use one DataTable per worksheet.
- Give the same name to the DataTable and worksheet.
- Use descriptive column names in the DataTables.
- Use Pascal casing. Each word of the DataTable name should begin with a capital letter (for example, `EmployeeLeaveRequests`).

Code naming conventions

As you add code to your PowerApps apps, it becomes increasingly important to use consistent naming conventions for variables and collections. If variables are named correctly, you should be able to quickly discern the *type*, *purpose,* and *scope* of each.

We found lots of variance in the code naming and object naming conventions of different organizations. For example, one team uses data type prefixes for its variables (such as `strUserName` to indicate a string), whereas another team prefixes all its variables with an underscore (_) to group them in IntelliSense. There are also differences in the way that teams denote global variables versus context variables.

The same guidance applies here: *Have a pattern for your team, and be consistent in its usage*.

Variable names

- Be descriptive of the variable's function. Think about what the variable is bound to and how it's used, and then name it accordingly.
- Prefix your global and context variables differently.

Be smart! PowerApps lets context variables and global variables share the same names. This can cause confusion, because, by default, your formulas use context variables unless the disambiguation operator is used. Avoid this situation by following these conventions:

- Prefix context variables with `loc`.
- Prefix global variables with `gbl`.
- The name after the prefix should indicate the intent/purpose of the variable. Multiple words can be used and don't have to be separated by any special characters (for example, spaces or underscores), provided that the first letter of each word is capitalized.
- Use Camel casing. Begin your variable names with a prefix in lowercase letters, and then capitalize the first letter of each word in the name (that is, `lowerUppperUpper`).

Here are some good examples:

- **Global variable:** `gblFocusedBorderColor`
- **Context variable:** `locSuccessMessage`

Here are some bad examples:

- `dSub`
- `rstFlds`
- `hideNxtBtn`
- `ttlOppCt`
- `cFV`
- `cQId`

Avoid short and cryptic variable names such as `EID`. Use `EmployeeId` instead.

Note: When there are many variables in an app, you can just type the prefix in the formula bar to see a list of the available variables. If you follow these guidelines to name your variables, you'll be able to find them very easily tin the formula bar as you develop your app. Ultimately, this approach leads to quicker app development.

Collection names

- Be descriptive of the collection's contents. Think about what the collection contains and/or how it's used, and then name it accordingly.
- Collections should be prefixed with `col`.
- The name after the prefix should indicate the intent or purpose of the collection. Multiple words can be used and don't have to be separated by spaces or underscores, provided that the first letter of each word is capitalized.
- Use Camel casing. Begin your collection names with a lowercase `col` prefix, and then capitalize the first letter of each word in the name (that is, `colUpperUpper`).

Here are some good examples:

- `colMenuItems`
- `colThriveApps`

Here are some bad examples:

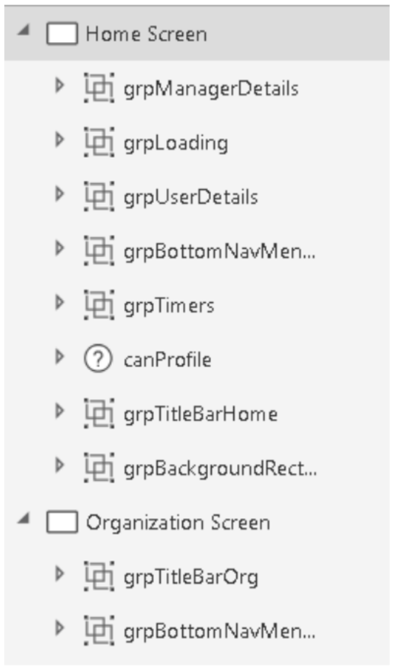
- `orderscoll`
- `tempCollection`

Note: When there are many collections in the app, you can just type the prefix in the formula bar to see a list the available collections. As for variables, if you follow these guidelines to name your collections, you'll be able to find them very easily in the formula bar as you develop your app. Ultimately, this approach leads to quicker app development.

Organizing your objects and code

Using groups for organization

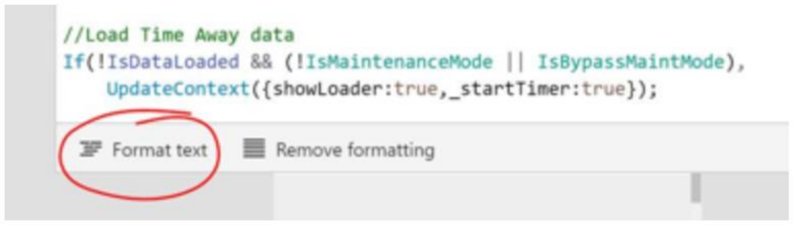
All controls on a screen should belong to a group, so that you can easily recognize their purpose, move them around a screen or between screens, or collapse them to simplify your view. Gallery, Form, and Canvas controls are already groups, but they can also, optionally, be part of another group to help improve organization.



Optionally, you can use the experimental enhanced Group control, which allows for nesting of groups, group-level settings, keyboard navigation, and more.

Format text feature

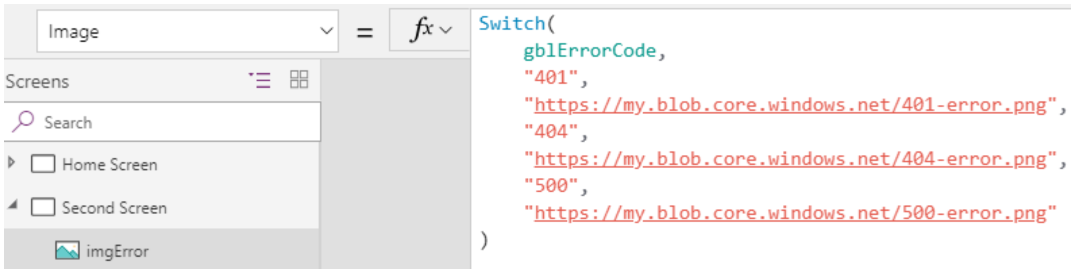
As the complexity of a formula increases, readability and maintainability are affected. It can be very difficult to read a large block of code that contains multiline functions. The **Format text** feature adds line breaks and indentation to make your formula easier to read. As for code comments, the extra white space is removed from the app package that's downloaded to the client. Therefore, there's no need to use the **Remove formatting** feature before you publish your app.



```
//Load Time Away data
If(!IsDataLoaded && (!IsMaintenanceMode || IsBypassMaintMode),
    UpdateContext({showLoader:true,_startTimer:true});
```

Minimizing the number of controls that you create

To minimize complexity, try to limit the number of controls in your apps. For example, instead of having four image controls that lie on top of each other and have different `Visible` property settings, use one image that includes logic in its `Image` property to show different images.



```
Switch(
    gblErrorCode,
    "401",
    "https://my.blob.core.windows.net/401-error.png",
    "404",
    "https://my.blob.core.windows.net/404-error.png",
    "500",
    "https://my.blob.core.windows.net/500-error.png"
)
```

Finding the best place for your code

As the complexity of your PowerApps apps increase, it can become more difficult to find your code when it's time to debug an application. A consistent pattern makes this challenge easier. Although this section isn't exhaustive, it provides some guidelines about the best place for your code.

As general guidance, try to move your code to the "top level" as much as possible, so that it's easier to find in the future. Some makers like to put code in the `OnStart` property. This approach is fine, provided that you understand the `OnStart` property's limitations, and possible perceived implications for app performance. Other makers prefer to put code in the `OnVisible` property, because it's easy to find, and code reliably runs whenever the screen is visible.

Code encapsulation

Whenever possible, try not to distribute your code across screens, so that all the code resides on one screen. For example, one maker built a people browser app that shows the organizational hierarchy in a gallery. When a user clicks a name, the app goes to a new screen and shows the employee profile. In this case, the maker didn't put the logic to load the profile in the gallery's `OnSelect` property. Instead, the app just passes any variables that are needed on the next screen as context variables in the `Navigate` function. The **User Profile** screen does all the work to load the user profile.

Here's the `Navigate` function in the gallery's `OnSelect` property for this example.

```
Navigate(
    'User Profile Screen',
    Cover,
    {
        locSelectedEmployeeID: ThisItem.id,
        locSelectedEmployeeName: ThisItem.displayName,
        locSelectedEmployeeJobTitle: ThisItem.jobTitle,
        locProfileFetchComplete: false,
        locDirectReportsFetchComplete: false,
        locMgrHierarchyFetchComplete: false,
        locPeersFetchComplete:false,
        locSelectedTab:"Profile"
    }
)
```

Then, in the `OnVisible` property of the **User Profile** screen, call `Office365Users.UserProfileV2` by using the user ID that was received from the previous screen. Subsequent code then uses the other context variables that were passed.

```
ClearCollect(colUserProfile, Office365Users.UserProfileV2(locSelectedEmployeeID))
```

Note: The previous example passes `ThisItem` values as context variables instead of having the next screen refer to the `Selected` property of the previous screen. This approach was used deliberately, because this app has multiple paths to the **User Profile** screen from other screens that include galleries. The screen is now encapsulated and can easily be reused in this app and other apps.

OnStart property

In general, try to limit the code that you put in the `OnStart` property, because it's difficult to debug. To debug code there, you must save, close, and then reopen your PowerApps app in PowerApps Studio to make the code run again. You can't create context variables in this property. Think of it as `Application.OnStart`, which runs only once before any screen is shown.

Here are the recommended uses for `OnStart`:

- **Screen routing**: Unlike the `OnVisible` property, you can use the `Navigate` function in the `OnStart` property. Therefore, it can be a handy place to make routing decisions. For example, you can evaluate a parameter named `mode` to determine which screen to show.

```
Navigate(
    Switch(
        Param("mode"),
        "new",
        'New Order Screen',
        "edit",
        'Edit Order Screen',
        "history",
        'Order History Screen',
        'Dashboard Screen'
    ),
    ScreenTransition.None
)
```

- **Impersonation or debug privileges**: You can create code in the `OnStart` property to check whether the current user is on a list of email addresses and, if the user is on the list, turn on a debug mode that shows hidden screens and text input controls.

```
Set(
    gblAllowDebug,
    If(
        User().Email in [
            "bob@contoso.com",
            "susan@contoso.com",
            "rajesh@contoso.com"
        ],
        true,
        false
    )
)
```

Note: You can also check Azure Active Directory (AAD) group membership to apply security settings to your apps.

- **Static global variables**: Use the `OnStart` property to create collections of error messages or set global style variables, such as control colors and border widths. For another approach, see the Creating a hidden configuration screen section later in this white paper.
- **"Run once" code**: By its definition, code that's put in the `OnStart` property runs only once, while the app is starting but before the first screen is visible. On the other hand, code in the `OnVisible` property runs every time a user goes to that screen. Therefore, if you need your code to run only once, consider putting it in the `OnStart` property.
- **Code that runs quickly:** For specific guidance about the `OnStart` property, see the Optimizing for performance section later in this white paper.

For more information about the `OnStart` and `OnVisible` properties, watch the PowerApps OnStart and OnVisible Development Tricks video by Todd Baginski.

OnVisible property

The `OnVisible` property is the place to put code that must run every time a user goes to a screen. Be careful about putting code in this property. If possible, avoid putting logic in the `OnVisible` property on the first screen of your PowerApps app. Instead, try to use inline expressions in control properties.

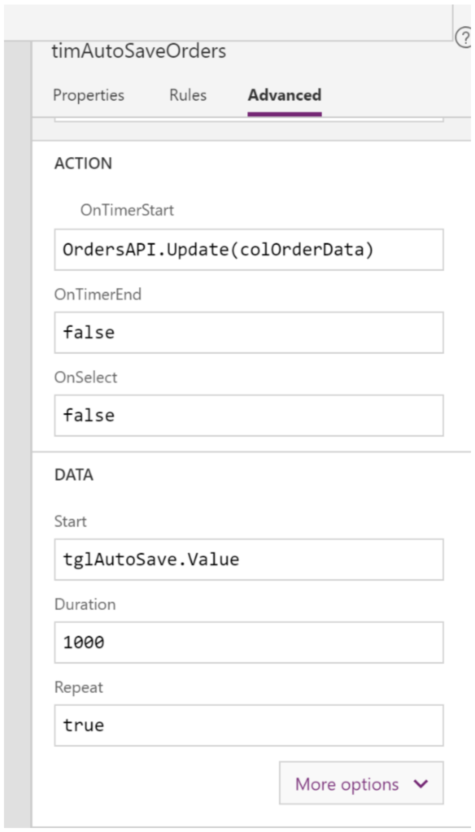
The `OnVisible` property is a great place to set global or context variables. However, be careful about the calls that you make to set those variables. Quick calls, such as calls to `Office365Users.Profile` or calls to set a static color for reuse in controls, are acceptable. However, stay away from complex logic and code that takes a long time to run.

For more information about performance issues that are related to the `OnVisible` property, see the Expensive calls section later in this white paper.

OnTimerStart property

Timers present interesting possibilities for event-based code execution. Typically, makers hide timer controls and set the `Start` property to watch a Boolean variable or control state.

For example, if you want to have a form that lets the user switch an auto-save feature on and off, you can create a toggle control that's named `tglAutoSave`. A timer on the screen then has its `Start` property set to `tglAutoSave.Value`, and code in the `OnTimerStart` property can save the data.



OnTimerStart
```
OrdersAPI.Update(colOrderData)
```
OnTimerEnd
```
false
```
OnSelect
```
false
```
Start
```
tglAutoSave.Value
```
Duration
```
1000
```
Repeat
```
true
```

In the `OnTimerStart` property, you can also put code that uses the `ClearCollect` function to reload data at a specified refresh interval.

The `OnTimerStart` property also supports the `Navigate` function. You can use it to go to another screen when specific conditions are met. For example, a loader screen sets a Boolean context variable when all data has been loaded, and the timer then goes to a data display screen. Alternatively, you can use this property to go to a "Session timed out" message screen after a period of inactivity.

This pattern comes with two caveats:

- The timer won't fire when you're editing the app in PowerApps Studio. Even if `AutoStart` is set to `true`, or an expression is evaluated as true in the `Start` property, the `OnTimerStart` property code won't be triggered. However, it will be triggered when you switch to Preview Mode (F5).

- Before the Navigate function fires, there can be enough of a delay for additional code to run on the screen.

  For example, you have a timer control on a loader screen. You set the control's Start property to locRedirect, a Boolean context variable, and you put the following navigation code in the OnTimerStart property.

```
If(
    locIsError,
    Navigate(
        'Error Screen',
        None,
        {locStatusMessage: locStatusMessage}
    ),
    Navigate(
        'Confirmation Screen',
        None,
        {locStatusMessage: locStatusMessage}
    )
)
```

  The OnVisible property of the loader screen retrieves the employee ID and sets locRedirect to false if the ID isn't numeric (because non-numeric employee IDs are error conditions).

```
//Get the employee ID from PeopleData
UpdateContext({locUserID: Text(PeopleData.PersonnelNumber)});
If(
    !IsNumeric(PeopleData.PersonnelNumber),
    //Couldn't get personnel number from basic profile call. error out
    UpdateContext(
        {
            locIsError: true,
            locStatusMessage: "Unable to retrieve user information",
            locRedirect: true //this will cause our redirect timer to fire
        }
    )
);
```

  When locRedirect is set to true, the timer control's OnStart code runs, but there's a slight delay, during which code in the OnVisible property continues to run. Therefore, do an additional error check for the next few lines of code.

```
//there is a small delay when a timer fires. Change the status message only if there is no error
If(
    !locIsError,
    UpdateContext({locStatusMessage: "Authorizing User..."})
);
//Get token
UpdateContext(
    {
        locSuccessFactorToken: LDService.GetSfToken(
            {
                scope: {
```

OnSelect property

Code in the OnSelect property of a control runs whenever that object is selected. Object selection can occur through user interaction, such as the click of a button or selection of a text input control. The code that runs here can validate form data and show validation messages or hint text, or it can read from and write to your data source.

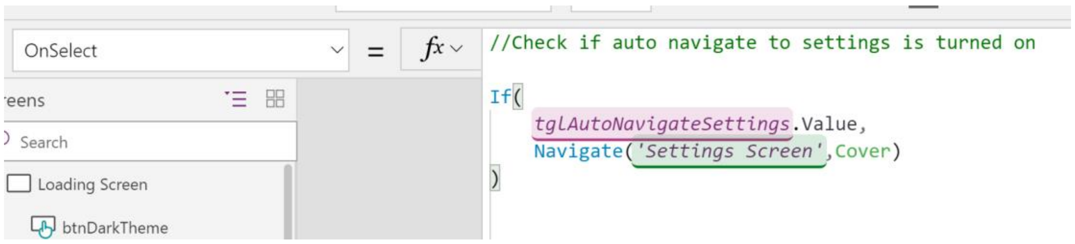
Note: Avoid putting long-running code in the `OnSelect` property, because long-running code can give the impression that the application has stopped responding. For more information, see the Optimizing for performance and Expensive calls sections later in this white paper. Also consider loading indicators or status messages to help prevent the perception of slowness.

Code that's put in the `OnSelect` property will also run when the control is selected by using the `Select` function. A useful pattern is to have a loader screen as the first screen of the application. A label control can show a message such as "Loading app data." The `OnSelect` property of this label control can call your data sources and initialize variables, and then navigate to the home screen of the application. The label control is then selected by calling the `Select` function in the application's `OnStart` property.

Although the initialization code can also reside in the `OnStart` or `OnVisible` property, there are benefits to this approach:

- `OnVisible` code doesn't allow for navigation. Therefore, you must add navigation code to a control, such as a timer.
- `OnStart` code will prolong the splash screen or, if the **Use non-blocking OnStart rule** preview feature is turned on, might have unexpected results.
- When the label control is programmatically selected, users who have a vision impairment will hear the text of the label control read to them by their screen reader as data is loaded. This pattern provides a great experience when a screen reader is used, as the user hears "Loading screen," "Loading app data," or "Home screen."

Caution: If you use the `Select` function in the `OnVisible` property to select a control, and that control then uses a `Navigate` function to go to another screen, it might not be possible to edit the screen. To avoid this situation, use a toggle control on a hidden settings screen in the app. Then check the state of this toggle in the `OnSelect` property before you call the `Navigate` function.



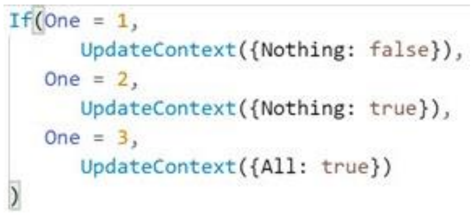
```
//Check if auto navigate to settings is turned on

If(
    tglAutoNavigateSettings.Value,
    Navigate('Settings Screen',Cover)
)
```

Other tips for organization

- Don't "nest" secondary logical tests by explicitly writing `If` after the initial statement.

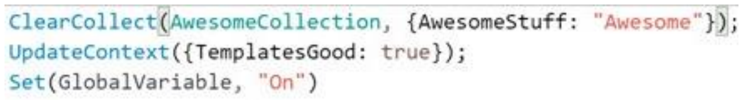
```
If(
    One = 1,
        UpdateContext({Nothing: false}),
    If(One = 2,
        UpdateContext({Nothing: true}),
    If(One = 3,
        UpdateContext({All: true})
)))
```

- To write secondary logical tests, just write the logical test, without explicitly writing `If`.



```
If(One = 1,
      UpdateContext({Nothing: false}),
   One = 2,
      UpdateContext({Nothing: true}),
   One = 3,
      UpdateContext({All: true})
)
```

- Avoid lengthy expressions whenever possible.
- To manually format your code, follow these guidelines:
  - Each semicolon should represent a line break.



```
ClearCollect(AwesomeCollection, {AwesomeStuff: "Awesome"});
UpdateContext({TemplatesGood: true});
Set(GlobalVariable, "On")
```

  - For long single-line formulas, try to insert line breaks in reasonable places: before and after parentheses, commas, and colons.

General coding guidelines

Click targets

If actions should be performed when a group of controls is clicked, there are three approaches that you can use:

- The simplest approach is to group the controls and then assign click events to the group's `OnSelect` property.
- Put the code in one of the controls in the group (the most significant control), and then add `Select(`*`controlWithLogic`*`)` to the `OnSelect` property of all the other controls in the group. As for the first approach, no additional controls are required, and the controls can easily be selected in the editor.
- Lay a transparent rectangle on top of the group, and use the rectangle's `OnSelect` property.

We recommend the third approach, because code isn't affected as much if the controls in the group change. This approach also gives the maker more flexibility about the shape of the clickable region. Although the controls inside the rectangle are more difficult to select directly on the screen, you can select them individually in the **Screens** pane on the left side of the editor.

For more information about this approach, see the article HOW TO: Use Transparent Rectangles Effectively In a PowerApp article by Todd Baginski.

Variables and collections

Context variables

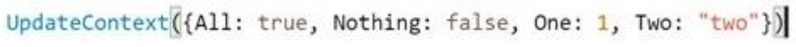
Limit your use of context variables. Try to use them only when they're absolutely necessary.

Know when to use context variables versus global variables. Use a global variable when you need it to be available on all screens. Use a context variable if you want to limit the scope of a variable to a single screen.

Avoid passing context variables between screens when a global variable might be more appropriate (and much easier to debug).

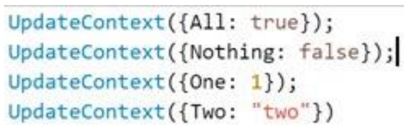
Update all necessary context variables in a single `UpdateContext` call. In this way, you make your code more efficient and easier to read.

For example, use this call to update several context variables.



```
UpdateContext({All: true, Nothing: false, One: 1, Two: "two"})
```

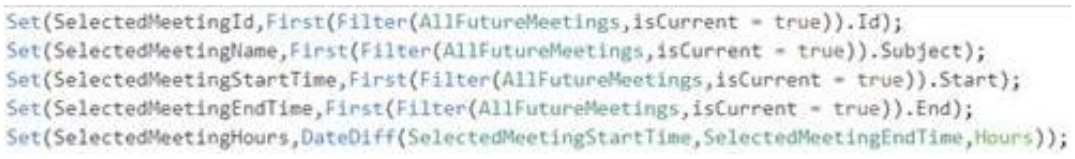
Don't use these separate calls.



```
UpdateContext({All: true});
UpdateContext({Nothing: false});
UpdateContext({One: 1});
UpdateContext({Two: "two"})
```

Global Variables

Don't use multiple variables when you can use just one. Here's an example of multiple variables.



```
Set(SelectedMeetingId,First(Filter(AllFutureMeetings,isCurrent = true)).Id);
Set(SelectedMeetingName,First(Filter(AllFutureMeetings,isCurrent = true)).Subject);
Set(SelectedMeetingStartTime,First(Filter(AllFutureMeetings,isCurrent = true)).Start);
Set(SelectedMeetingEndTime,First(Filter(AllFutureMeetings,isCurrent = true)).End);
Set(SelectedMeetingHours,DateDiff(SelectedMeetingStartTime,SelectedMeetingEndTime,Hours));
```

Instead, you can use just one variable, as shown here.

```
Set(SelectedMeeting, ThisItem);

SelectedMeeting.Id;
SelectedMeeting.Subject;
SelectedMeeting.Start;
SelectedMeeting.End;
SelectedMeeting.Start;
DateDiff(SelectedMeeting.Start, SelectedMeeting.End, Hours)
```

Collections

Limit your use of collections. Try to use them only when they're absolutely necessary.

Use `ClearCollect` instead of `Clear;Collect`.

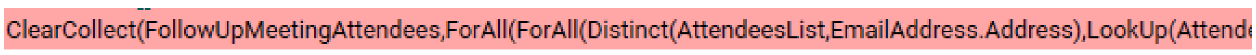
```
//Use this pattern
ClearCollect( colErrors, { Text: gblErrorText, Code: gblErrorCode } );

//Not this pattern
Clear(colErrors);
Collect( colErrors, { Text: gblErrorText, Code: gblErrorCode } )
```

To count the records in a local collection, use `CountIf` instead of `Count(Filter())`.

Nesting

Avoid using unnecessary DataCards and canvases, especially if they have nested galleries.

Avoid nesting in other operators too, such as the `ForAll` function.



```
ClearCollect(FollowUpMeetingAttendees,ForAll(ForAll(Distinct(AttendeesList,EmailAddress.Address),LookUp(Attend
```

Note: A previous version of this document stated that nested galleries would be deprecated. This is incorrect and we apologize for the error.

Optimizing for performance

OnStart code

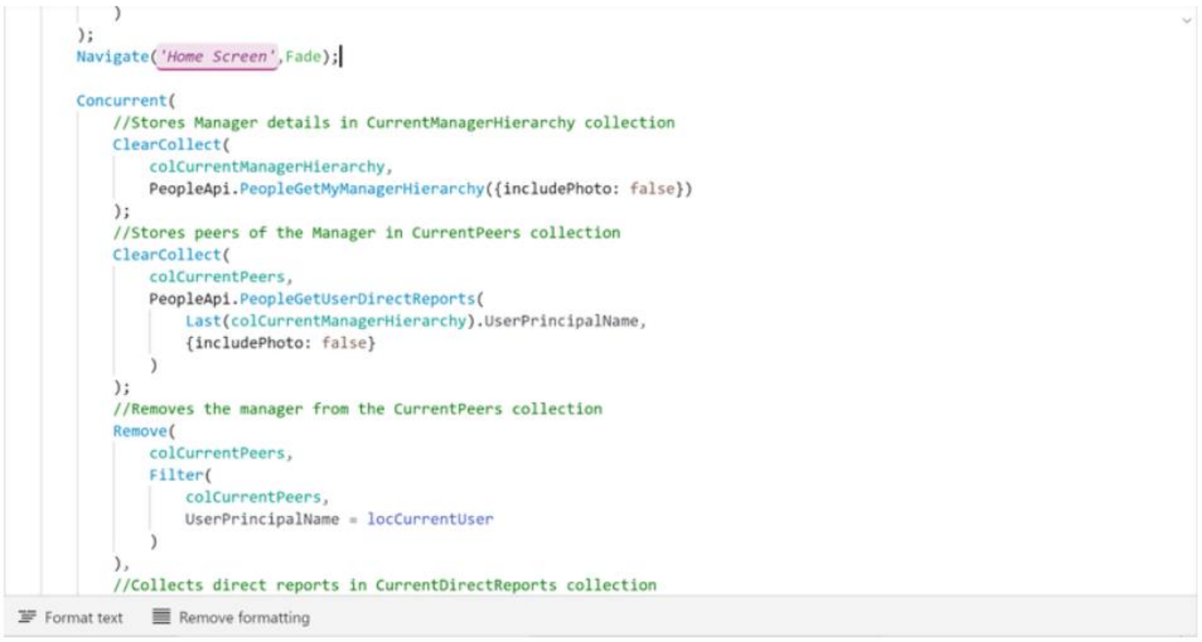
The `OnStart` property is invaluable for those one-time calls that are needed to initialize your apps. It might be tempting to put your data initialization calls in this property too. However, while `OnStart` code is running, the user will continue to see the app splash screen and a "Getting your data" message, and the perceived load times will be longer.

For a better user experience, we recommend that you let the home screen be shown with placeholders for data, such as double dashes (--). Then fill in the data after it's retrieved. In this way, the user can begin to read content on the home screen or interact with controls that aren't data-dependent. For example, the user can open an **About** screen.

Concurrent function

PowerApps runs your data source calls from top to bottom in a module. If you have several calls, this linear execution can negatively affect app performance. One workaround for this issue has been to use timer controls to concurrently fire data calls. However, this approach is difficult to maintain and debug, especially when some timers depend on other timers.

The `Concurrent` function eliminates the need to use timer controls to make multiple data calls at the same time. The following code snippet replaces several API calls that used to reside in the `OnTimerStart` property of timer controls in the app. This approach is much easier to maintain.



```
        )
    );
    Navigate('Home Screen',Fade);

    Concurrent(
        //Stores Manager details in CurrentManagerHierarchy collection
        ClearCollect(
            colCurrentManagerHierarchy,
            PeopleApi.PeopleGetMyManagerHierarchy({includePhoto: false})
        );
        //Stores peers of the Manager in CurrentPeers collection
        ClearCollect(
            colCurrentPeers,
            PeopleApi.PeopleGetUserDirectReports(
                Last(colCurrentManagerHierarchy).UserPrincipalName,
                {includePhoto: false}
            )
        );
        //Removes the manager from the CurrentPeers collection
        Remove(
            colCurrentPeers,
            Filter(
                colCurrentPeers,
                UserPrincipalName = locCurrentUser
            )
        ),
        //Collects direct reports in CurrentDirectReports collection
```

To fire these calls, you can put them in the `OnVisible` property. Alternatively, if that approach becomes too messy, you can put the calls in a timer control, and set the variable referenced in the timer's `Start` property either in the `OnVisible` property or in the `OnSelect` property of a hidden control. You can also combine timers with other controls to show a loading message while the code in the `OnVisible` property run. This approach is a great way to let your users know that the app is doing something. For more information, see the Finding the best place for your code section earlier in this white paper.

Note: To make code easier to maintain, you might prefer to use the `OnVisible` property. However, if you use `OnVisible`, you won't be able to use the `Navigate` function.

To see the `Concurrent` function in action, see Todd Baginski's video, HOW TO: Use the Concurrent Function To Make Your PowerApps Perform Better.

Delegable calls vs. non-delegable calls

When you call your data sources, be aware that some functions are delegable, but others aren't. Delegable functions can be evaluated on the server and will be more performant. Non-delegable functions require that data be downloaded to the client and evaluated locally. This process is slower and more data-intensive than a delegable call.

For more information, see the Understand Delegation in a Canvas App article.

Using local collections

For smaller datasets, especially when frequent access is an issue, consider loading the datasets into local collections first. You can then perform your functions on, or bind controls to, those collections. This approach will be especially beneficial if you make frequent non-delegable calls. Just be aware that there will be an initial effect on performance because the data must be retrieved and there are limits on the number of records that are returned. For more information, see Mehdi Slaoui Andaloussi's great blog post, Performance considerations with PowerApps.

SQL optimization

Your organization might be using Azure SQL Database for your data back end, to take advantage of its rich administration capabilities and interoperability. However, a poorly implemented design won't handle concurrency, and you might have to increase the database transaction unit (DTU) size and, therefore, the cost.

For example, Microsoft IT built the Thrive Conference app for an internal conference that had 1,700 attendees. The back end was a 100-DTU SQL Database instance. During performance testing, Microsoft asked 120 employees in its operations center to open the app simultaneously. The app stopped responding. Network traces showed that HTTP `500` errors were thrown from the PowerApps connection object. The SQL logs indicated that the server was fully utilized, and that calls were timing out.

Because there was no time to rewrite the app before the conference, Microsoft IT increased the scale to 4,000 DTU to meet the concurrency requirements. Therefore, the cost was significantly higher than the 100-DTU server that was originally budgeted. Since then, Microsoft IT has optimized the design by using the approach that's described here. Now, a 100-DTU server is more than enough to handle the load, and the SQL calls are substantially faster.

Delegable functions for SQL

After you've read the previous section for an overview of delegation, see the list of data sources and supported delegation to understand which top-level functions and which predicates of the `Filter` and `Lookup` functions are supported. This information will make a big difference in the performance of your PowerApps apps, especially on mobile devices, because the whole dataset doesn't have to be downloaded and evaluated on the client.

Using views instead of tables

Instead of traversing from table to table to get your data, expose views where the joins have been made for you. Provided that you've correctly indexed your tables, this approach should be very fast, and it will be even faster if you limit the results by using a delegable function that runs on the server.

Using stored procedures through a flow for performance

The biggest performance improvement that you can make for a PowerApps app that uses Microsoft SQL Server is to call stored procedures from an implementation of Microsoft Flow (that is, a flow). This approach has the added benefit of decoupling your database design from the PowerApps app. Therefore, you can change the underlying table structure without affecting your app. As we'll explain later, this approach is also more secure.

To use this approach in a PowerApps app that already uses the SQL Server connector, you must first completely remove the SQL Server connector from the app. Then create a new SQL Server connector that uses a SQL sign-in that's restricted to EXECUTE permissions on stored procedures in the database. Finally, in the flow, call the stored procedure, and pass in the parameters from the PowerApps app.

For a detailed explanation of how to create the flow and return its results to PowerApps, see Brian Dang's article, Return an array from a SQL Stored Procedure to PowerApps (Split Method).

This approach has these performance benefits:

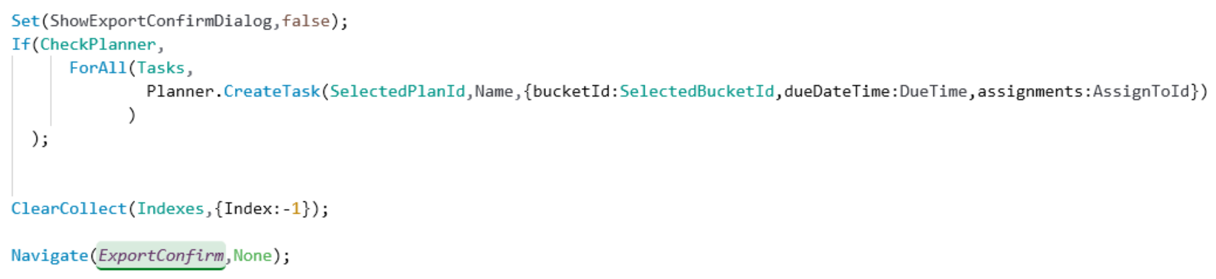
- The stored procedure will be optimized through a query execution plan. Therefore, data will be returned faster.
- Delegable calls become less of an issue, because your stored procedure will be optimized to read or write only pertinent data.
- Your optimized flow is now a reusable component. Therefore, it's available to other makers in the environment for common read and write scenarios.

Expensive calls

Some of your data or API calls will be expensive or time-consuming. Long execution times will affect your perceived performance. Here are some tips:

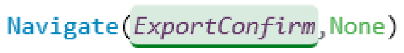
- Don't make expensive calls before the next page is opened. Try to make the loading of the next page instantaneous. Then, on the next page, in the background, make the calls in the `OnVisible` property.
- Use a loading message box or spinner to let the user know that progress is being made behind the scenes.
- The `Concurrent` function is a great way to make your calls to run in parallel. However, when this approach is used, long-running calls can block subsequent code from running.

Here's a bad example in an `OnSelect` property that goes to the next page.



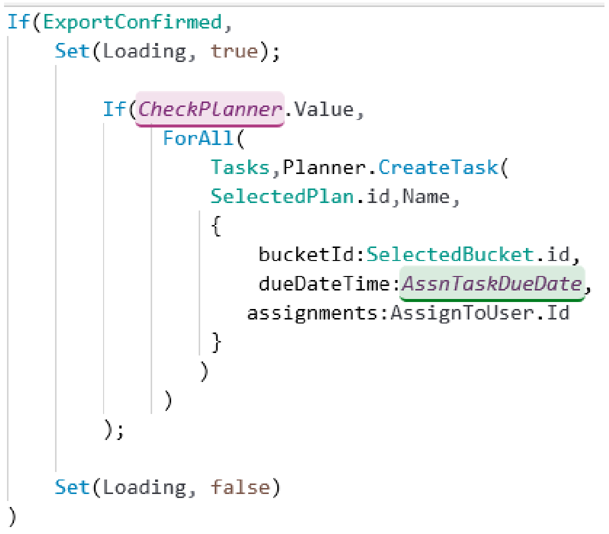
```
Set(ShowExportConfirmDialog,false);
If(CheckPlanner,
      ForAll(Tasks,
            Planner.CreateTask(SelectedPlanId,Name,{bucketId:SelectedBucketId,dueDateTime:DueTime,assignments:AssignToId})
          )
  );


ClearCollect(Indexes,{Index:-1});

Navigate(ExportConfirm,None);
```

Here’s a better example. First, here’s the code in the `OnSelect` property.



```
Navigate(ExportConfirm,None)
```

And here’s the code in the `OnVisible` property in the next page.



```
If(ExportConfirmed,
    Set(Loading, true);

        If(CheckPlanner.Value,
             ForAll(
                 Tasks,Planner.CreateTask(
                 SelectedPlan.id,Name,
                 {
                     bucketId:SelectedBucket.id,
                     dueDateTime:AssnTaskDueDate,
                    assignments:AssignToUser.Id
                 }
                )
             )
        );

    Set(Loading, false)
)
```

Limiting the package size

Although PowerApps does a lot to optimize app loading, you can take steps to reduce the footprint of your apps. A reduced footprint will be especially important for users of older devices, or users in locales where there’s higher latency or reduced bandwidth.

- Evaluate the media that are embedded in your app. If something isn’t used, delete it.
- Embedded images might be too big. Instead of PNG files, see whether you can use SVG images. However, be careful about using text in SVG images, because the font that’s used will have to be installed on the client. A great workaround when you need to show text is to superimpose a text label over an image.
- Evaluate whether the resolution is appropriate for the form factor. The resolution for a mobile app doesn’t need to be as high as the resolution for a desktop app. Experiment to get the right balance of image quality and size.
- If you have unused screens, delete them. Be careful not to delete any hidden screens that only app makers or administrators use.
- Evaluate whether you’re trying to fit too many workflows into one app. For example, do you have both admin screens and client screens in the same app? If so, consider breaking them into individual apps. This approach will also make it easier for multiple people to work on the apps at the same time, and it will limit the “blast radius” (amount of testing) when app changes require a full test pass.

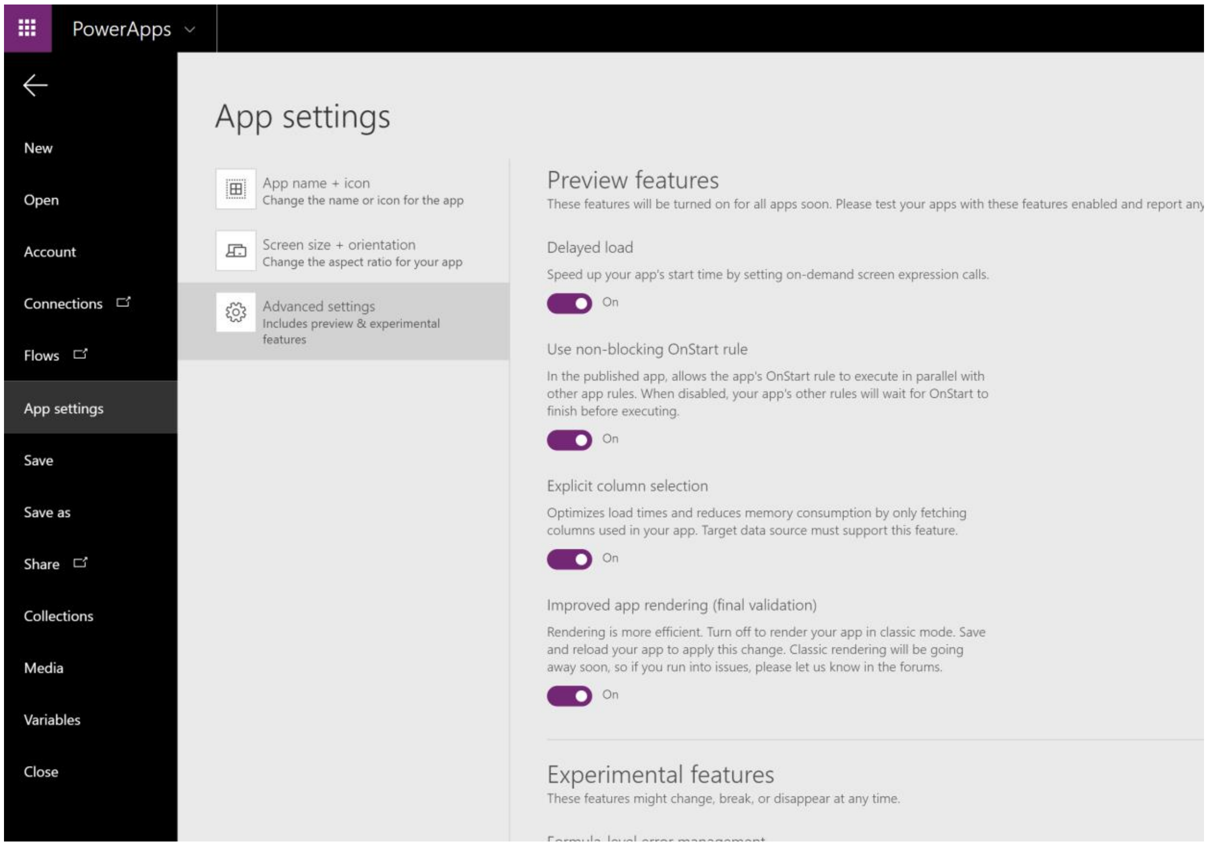
Periodically republishing your apps

The PowerApps product team is continually optimizing the Power platform. Sometimes, for backwards compatibility, these optimizations will apply only to apps that are published by using a certain version or later. Therefore, we recommend that you periodically republish your apps to take advantage of these optimizations.

Advanced settings

The PowerApps product group offers preview features that makers can optionally turn on for their applications. Some of these features can give your apps a significant performance boost. For example, the **Delayed load** feature turns on lazy loading for your application. Then, during the initial load, the runtime will load only the screens and code that are required to show the first screen.

Use these features at your own risk, and be sure to test your apps thoroughly when you experiment with these features.



App settings

App name + icon
Change the name or icon for the app

Screen size + orientation
Change the aspect ratio for your app

Advanced settings
Includes preview & experimental features

Preview features
These features will be turned on for all apps soon. Please test your apps with these features enabled and report any

Delayed load
Speed up your app's start time by setting on-demand screen expression calls.
On

Use non-blocking OnStart rule
In the published app, allows the app's OnStart rule to execute in parallel with other app rules. When disabled, your app's other rules will wait for OnStart to finish before executing.
On

Explicit column selection
Optimizes load times and reduces memory consumption by only fetching columns used in your app. Target data source must support this feature.
On

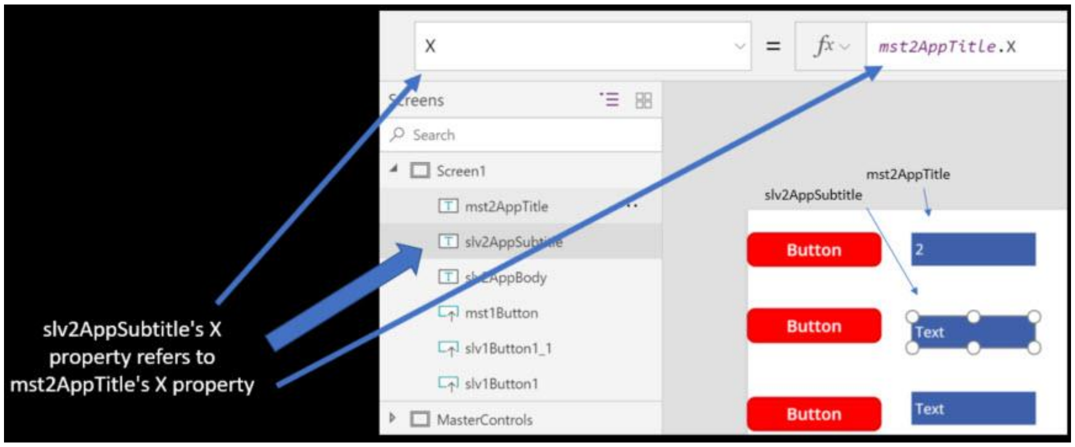
Improved app rendering (final validation)
Rendering is more efficient. Turn off to render your app in classic mode. Save and reload your app to apply this change. Classic rendering will be going away soon, so if you run into issues, please let us know in the forums.
On

Experimental features
These features might change, break, or disappear at any time.

App design

Using parent/child relationships for relative styling

We recommend that you use one control’s style as the basis for styling other controls. In general, use relative styling for the color, fill, x, y, width, and height properties.

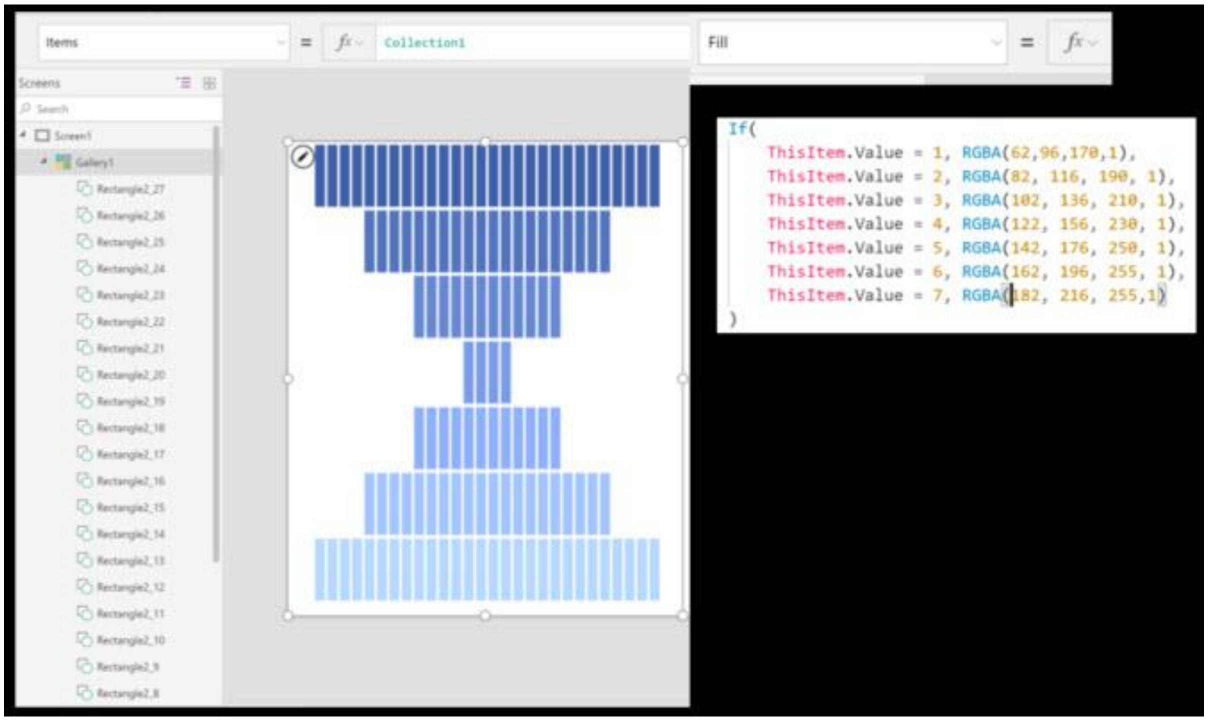


Galleries

Use galleries for almost everything that’s repetitive and linear.

The “brute force” (manual placement of multiple controls) method might be faster initially, but it will be very time-consuming to modify later.

If you must present a series of information or controls that seem repetitive, always consider whether you might be able to create a internal collection by using a gallery.



```
If(
    ThisItem.Value = 1, RGBA(62,96,170,1),
    ThisItem.Value = 2, RGBA(82, 116, 190, 1),
    ThisItem.Value = 3, RGBA(102, 136, 210, 1),
    ThisItem.Value = 4, RGBA(122, 156, 230, 1),
    ThisItem.Value = 5, RGBA(142, 176, 250, 1),
    ThisItem.Value = 6, RGBA(162, 196, 255, 1),
    ThisItem.Value = 7, RGBA(182, 216, 255,1)
)
```

It’s also useful to use a Gallery control as a view form, instead of using a Display Form control.

For example, you have a three-screen “app from data” app. There’s a **Users** data source that contains the user’s name, job title, and phone number.

The first screen, the **User List** screen, has a control that’s named `galUsers`. This control lists all users.

The second screen, the **User Details** screen, just has a gallery control that’s named `galUserDetails`. The `Items` property of this control is set as shown here.

```
Table(
    {Title: "User Name", Value: galUsers.Selected.DisplayName},
    {Title: "Job Title", Value: galUsers.Selected.JobTitle},
    {Title: "Phone Number", Value: galUsers.Selected.PhoneNumber}
)
```

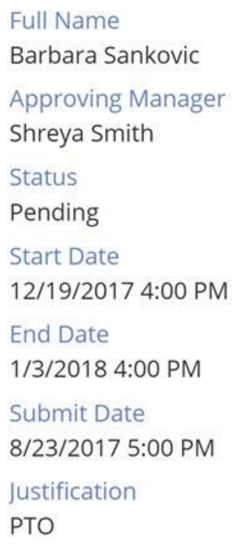
This method is much faster than trying to modify three separate data cards in a display form.

Forms

Use forms for repetitive data entry fields.

Forms also let you quickly group several fields instead of having to use several text boxes.

A form is much easier to work with than individual text boxes, because forms let you to take advantage of parent/child relationships to implement relative styling.


Full Name
Barbara Sankovic
Approving Manager
Shreya Smith
Status
Pending
Start Date
12/19/2017 4:00 PM
End Date
1/3/2018 4:00 PM
Submit Date
8/23/2017 5:00 PM
Justification
PTO

Common Data Service for Apps

We recommend that you use a single screen to handle edit/insert operations.

If possible, use a CardGallery control to handle updates to data, instead of referencing individual controls in a `Patch` function.

When you name context variables, you should indicate which record they’re associated with.

Multiple form factors

When you make the same PowerApps app target both phone and tablet layouts, first create one version of the app, run it through testing, and finalize it. Then convert it to the other version before you modify the layout and screens. This approach helps guarantee that your expressions, controls, variables, data sources, and so on, all have the same names. Therefore, it's **much** easier to support the apps and develop them. To learn how to convert one form factor to another, see the How to convert a PowerApp from one layout to another article on Todd Baginski's blog.

Configuration values

You likely use `SaveData` and `LoadData` to store user-defined settings in your mobile apps. They provide a handy way of caching data.

Note: `SaveData` and `LoadData` *work only inside the PowerApps player client app.* Keep this limitation in mind as you design your apps, because these functions won't work when PowerApps apps are loaded in web browsers.

Your app will probably need to have application settings that can be easily changed in one place, such as color schemes, URLs to other apps, or settings that define whether debugging controls are visible on app screens. Therefore, the people who deploy your application can quickly set those values, and there's less risk that the code will be messed up during deployments. Think of these settings like an ASP.NET web.config file.

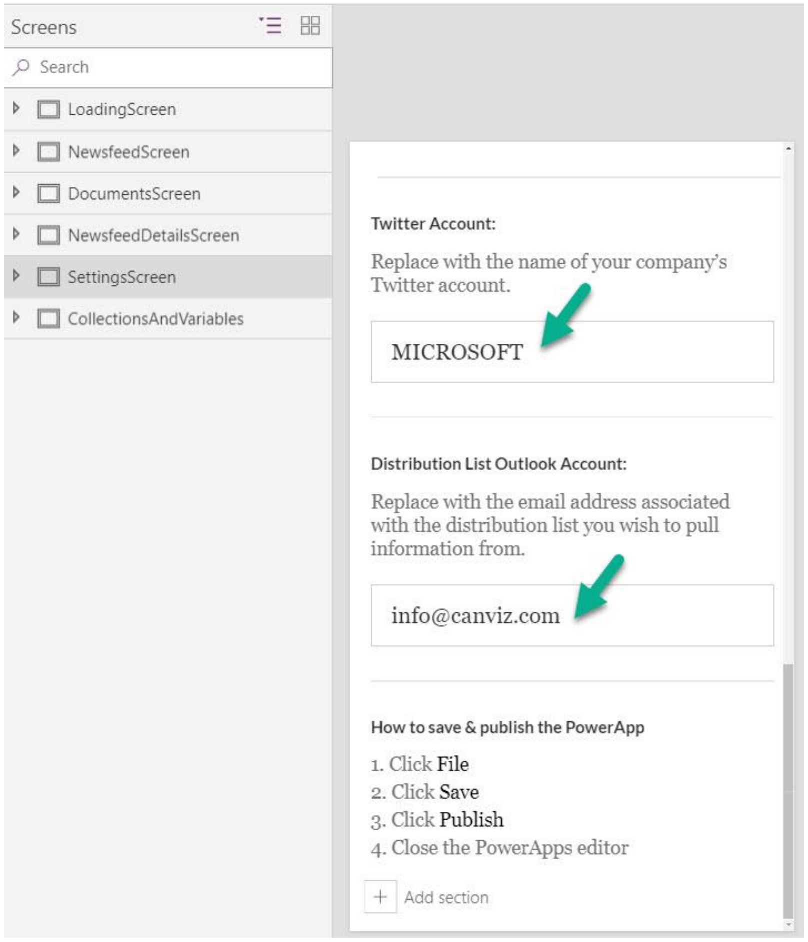
Here are several approaches to storing configuration values, in order of increasing difficulty.

Creating a hidden configuration screen

A surprisingly easy way of setting configuration values is just to create a hidden screen and put your configuration values in text input controls. In this way, you can change application settings without editing code. To use this approach, follow these steps:

1. Make sure that the configuration screen isn't the first screen in the application. Put it anywhere else in your screen order. We recommend that you make it the last screen, so that it's easily found.
2. Make sure that your users can't go to the screen.
3. Give yourself a way of going to the screen. The easiest way is to make the screen accessible only when the app is edited, and then manually go to the screen. On the home screen of the app, you might even have a hidden button that's only visible to app makers and admins, and that lets them go to the configuration screen. You can verify that users are app makers or admins by checking their email address (for example, check `User().Email`) or their AAD group membership, or use the PowerApps for Makers connector.

The following example is from the Microsoft PowerApps Company Pulse sample template. Here, you can see text input controls that let the PowerApps admin configure application setting values.



Twitter Account:

Replace with the name of your company's Twitter account.

MICROSOFT

Distribution List Outlook Account:

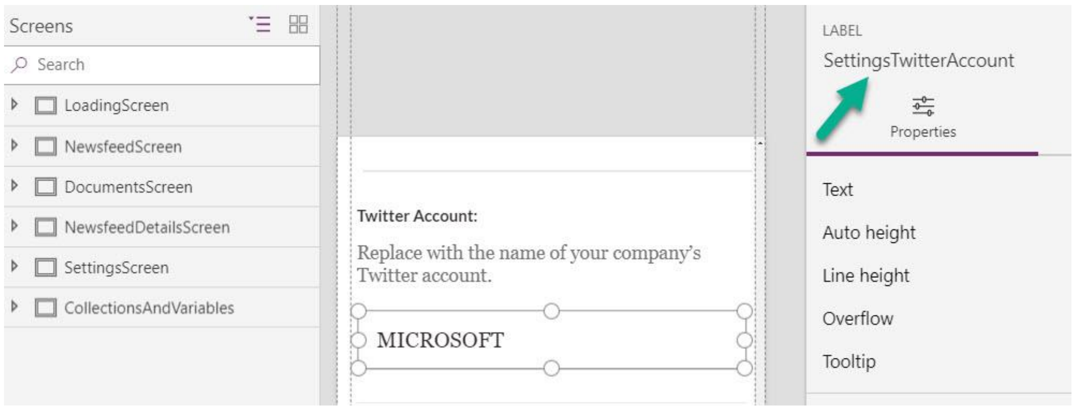
Replace with the email address associated with the distribution list you wish to pull information from.

info@canviz.com

How to save & publish the PowerApp

1. Click File
2. Click Save
3. Click Publish
4. Close the PowerApps editor

Here, you can see the name of the control that stores the Twitter account settings value.

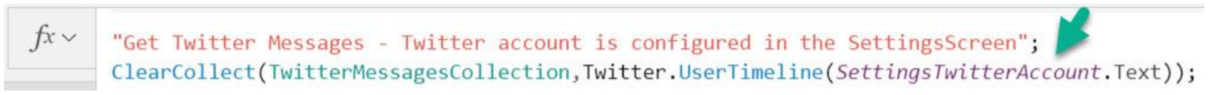


Twitter Account:

Replace with the name of your company's Twitter account.

MICROSOFT

Here, you can see where the value is used to return tweets for the Twitter account from the Twitter connector.



```
"Get Twitter Messages - Twitter account is configured in the SettingsScreen";
ClearCollect(TwitterMessagesCollection,Twitter.UserTimeline(SettingsTwitterAccount.Text));
```

Although this approach is the easiest way of changing values, it does have some downsides:

- You must republish the app to change values and make them persist.
- Because values persist in the app, you must create a process that updates these values before you export the app in preparation for a move to another environment.

Storing configuration values in Common Data Service for Apps

Alternatively, you can create a new Common Data Service for Apps entity and store configuration values there. Because the values persist outside the app, they can be modified at any time without redeploying the app. Common Data Service for Apps entities can have unique values per environment. For example, URLs can be different in pre-production and production environments.

Although this approach is a great way of maintaining configuration values, it also has downsides:

- Unlike the text input control approach, this approach requires a call-back to Common Data Service for Apps. Therefore, there will be a slight effect on performance, and if Common Data Service for Apps is unavailable (for example, if the user is on a mobile device and loses his or her connection), the app might not be shown correctly.
- Because there's no caching, a new call will be made every time the app is opened.
- There's no monitoring if the call fails. You'll have to rely on your users to inform you of app failures.

Using a custom API

Although implementation approach is the most difficult, Microsoft IT has had success with an Azure app service that stores configuration values as name/value pairs in Azure Table storage.

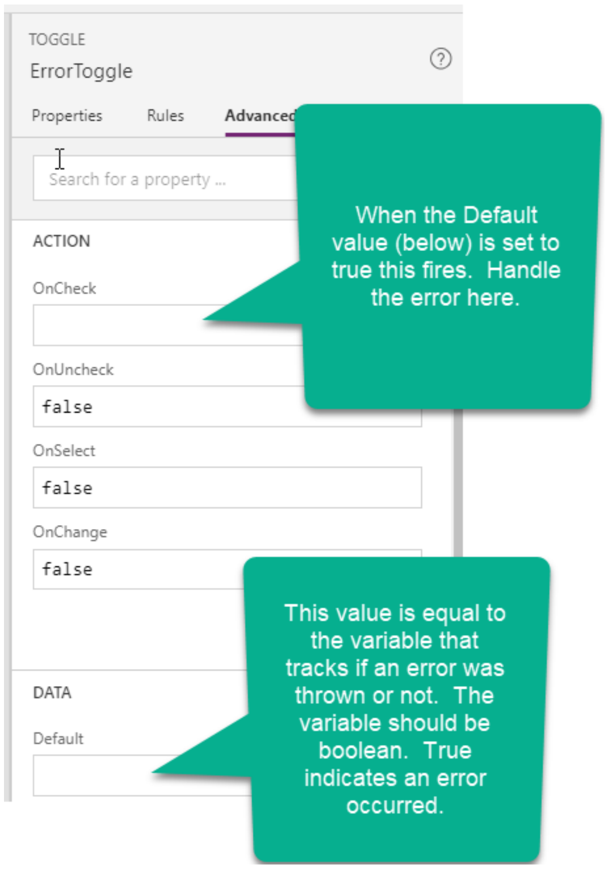
An OAuth secured custom connector fetches the configuration values, and output caching (which includes cache invalidation as values change) enhances performance. Azure Application Insights with alerts sends notifications when there's an issue and makes it much easier to troubleshoot a user session.

Error handling/debugging

Toggle controls for error handling

In the OnTimerStart property section, we demonstrated one pattern that you can use to handle errors with Timer controls. Another pattern that you can use to handle errors involves a Toggle control.

The following illustration shows this approach.


TOGGLE
ErrorToggle
Properties
Rules
Advanced
Search for a property ...
ACTION
OnCheck
OnUncheck
false
OnSelect
false
OnChange
false
DATA
Default
When the Default value (below) is set to true this fires. Handle the error here.
This value is equal to the variable that tracks if an error was thrown or not. The variable should be boolean. True indicates an error occurred.

In this approach, logic for validation and/or error handling can be encapsulated inside a single control. The Toggle control can evaluate complex conditions and issue a `true` or `false` value. Other controls can then reference that value to show/hide error messages, change font or border colors, make buttons unavailable, log to Application Insights, and much more. If you make this control visible and editable, the app maker can switch the error condition on and off to watch the user interface (UI) react. This approach can save time and effort when you develop or debug the app.

Using a canvas control as a debug panel

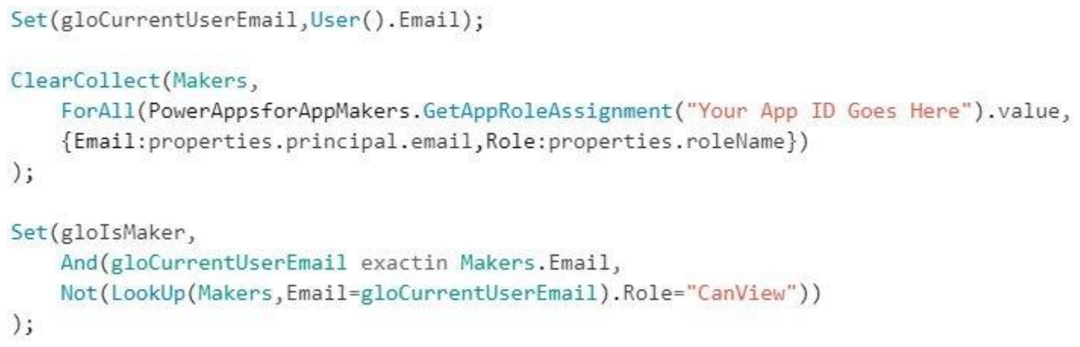
As you're developing your app and testing it, you can use a canvas control to create a semi-transparent debugging panel that appears over the top of your screens. This panel can then have editable fields, toggles, or other controls, as needed, so that you can change your variables while the app is in play mode.

For a step-by-step instructional video, see PowerApps - Best Practices: Debug Panel by Brian Dang.

Showing debug controls to app makers

You don't want to show your debug controls to all your users. Therefore, you must either manually toggle the `Visible` property of your debug control (in PowerApps Studio) or automatically toggle control visibility for certain users.

One elegant approach is to add the PowerApps for Makers connector. Despite the name, this connector can be used by non-makers for read-only calls. Then call the `GetAppRoleAssignments` function to determine whether the signed-in user is a maker for the current app.



```
Set(gloCurrentUserEmail,User().Email);

ClearCollect(Makers,
    ForAll(PowerAppsforAppMakers.GetAppRoleAssignment("Your App ID Goes Here").value,
    {Email:properties.principal.email,Role:properties.roleName})
);

Set(gloIsMaker,
    And(gloCurrentUserEmail exactin Makers.Email,
    Not(LookUp(Makers,Email=gloCurrentUserEmail).Role="CanView"))
);
```

For this example, you'll then set the `Visible` property of your debug controls to `gloIsMaker`, so that those controls appear only to app users who have maker permissions.

The benefit of this approach is that you won't need to use a configuration table to specify special debug permissions.

You can also show and hide debug controls for just app makers or admins by checking their email address (for example, check `User().Email`) or their AAD group membership.

Documentation

Code comments

As of June 2018, you can add comments to your code. As you write code in your application, be sure to heavily comment it. Comments will help you when you return to your application months later, and the next developer who works on the app will thank you for them.

There are two kinds of comments:

- **Line comments:** If a double forward slash (`//`) is added to any line of code, PowerApps will treat the rest of the line (including the `//`) as a comment. Use line comments to explain what happens next. You can also use them to temporarily disable a line of code without deleting it (therefore, they're useful for testing).
- **Block comments:** Any text that's wrapped inside `/*` and `*/` will be treated as a comment. Whereas line comments comment out only a single line, block comments can comment out multiple lines. Therefore, they're useful for multiline comments (such as a code module header). You can also use them to temporarily disable multiple lines of code while you're testing or debugging.

We recommend that you add comments **after** you use the **Format text** feature, especially if your comments precede a code block. The **Format text** feature uses the following logic for existing comments:

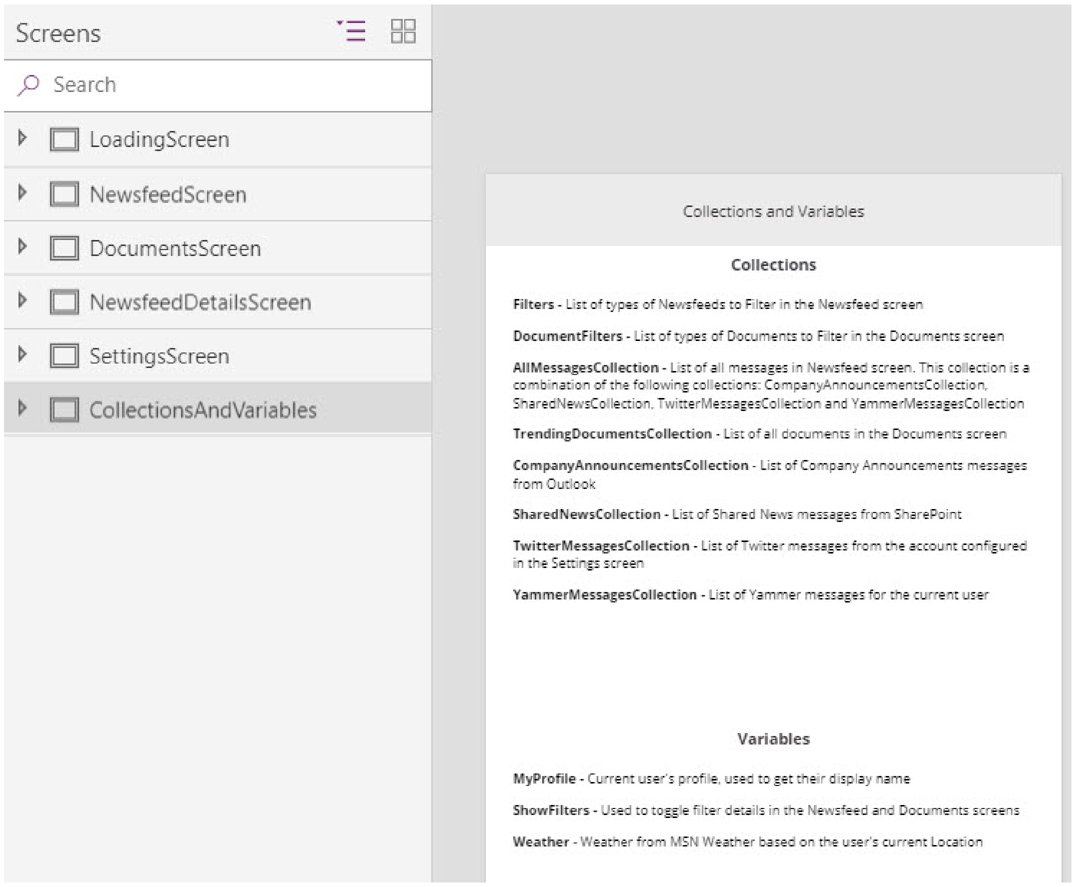
1. If a property begins with a block comment, the next line of code will be appended to it.
2. If a property begins with a line comment, the next line of code won't be appended to it. Otherwise, the code will be commented out.
3. Line and block comments everywhere else in the property will be appended to the previous line of code.

Don't worry about adding too many comments or comments that are too long. All comments will be stripped out when PowerApps creates the client app package. Therefore, they won't affect the package size or slow down the app download or loading times.

Documentation screens

We recommend that you create screens to document the collections and variables that are used in the PowerApps app. Don't link to these screens from the other screens in your app. These screens are seen only when the app is open in edit mode.

Here's an example from the Microsoft PowerApps Company Pulse sample template.



Collections and Variables

Collections

Filters - List of types of Newsfeeds to Filter in the Newsfeed screen

DocumentFilters - List of types of Documents to Filter in the Documents screen

AllMessagesCollection - List of all messages in Newsfeed screen. This collection is a combination of the following collections: CompanyAnnouncementsCollection, SharedNewsCollection, TwitterMessagesCollection and YammerMessagesCollection

TrendingDocumentsCollection - List of all documents in the Documents screen

CompanyAnnouncementsCollection - List of Company Announcements messages from Outlook

SharedNewsCollection - List of Shared News messages from SharePoint

TwitterMessagesCollection - List of Twitter messages from the account configured in the Settings screen

YammerMessagesCollection - List of Yammer messages for the current user

Variables

MyProfile - Current user's profile, used to get their display name

ShowFilters - Used to toggle filter details in the Newsfeed and Documents screens

Weather - Weather from MSN Weather based on the user's current Location