

Mobile Device App for Maintaining CMS Field Elements

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Problem

- Can't connect to a sign from the TMC, what do you do?
 - Verify loss of connectivity to sign using alternative TMC tools (ATMS, IRIS, SOCCS, etc.)
 - Verify status of communications network
 - Can you contact nearby field elements of same or different type (CMS, Camera, etc.)?
 - Alternatively, can you connect to on-site networking equipment, embedded computers, etc?
 - Call IT
 - Send someone to the sign

Problem

- Is there someone nearby already in the field?
- Do they have what they need in their truck?
- Currently available diagnostic equipment
 - Laptop, batteries, power supplies
 - Cobbled set of non - specific software
 - Software/OS typically locked down (i.e. difficult to configure on-site)
 - Bulky cables and adapters
- Wouldn't it be great if we had a complete portable diagnostic kit?

History

- Prior work (great idea)
 - Hand-held Diagnostics Terminal Kit (2009)
 - Supports basic CMS & CCTV (PTZ)
 - Hardware QSI G-58
 - Non-touch screen
 - Wired Ethernet (RJ-45)
 - Serial RS-232, 422, 485
 - Limited cabling/adapters
 - Software
 - Modular
 - Proprietary OS
 - Proprietary language (Qlarity)



History

- Prior work (continued)
 - Field evaluated
 - Partially deployed
 - QSI G-58 reached EOL

Next Generation

- Evolution of the Hand-Held Diagnostics Terminal system
 - Based on ubiquitous smartphones and tablets
 - Instant familiarity with user environment
 - Focused intuitive app per ITS element
 - Full multi-version protocol support
 - Significantly enhanced number of supported field hardware configurations

Supported Signs

- CMS 500 – 96 x 25 matrix
- CMS 510 – 96 x 25 matrix
- CMS 520 – 48 x 25 matrix
- AVMS 710 – 105 x 27 matrix
- AVMS 720 – 95 x 27 matrix
- AVMS 730 – 55 x 27 matrix

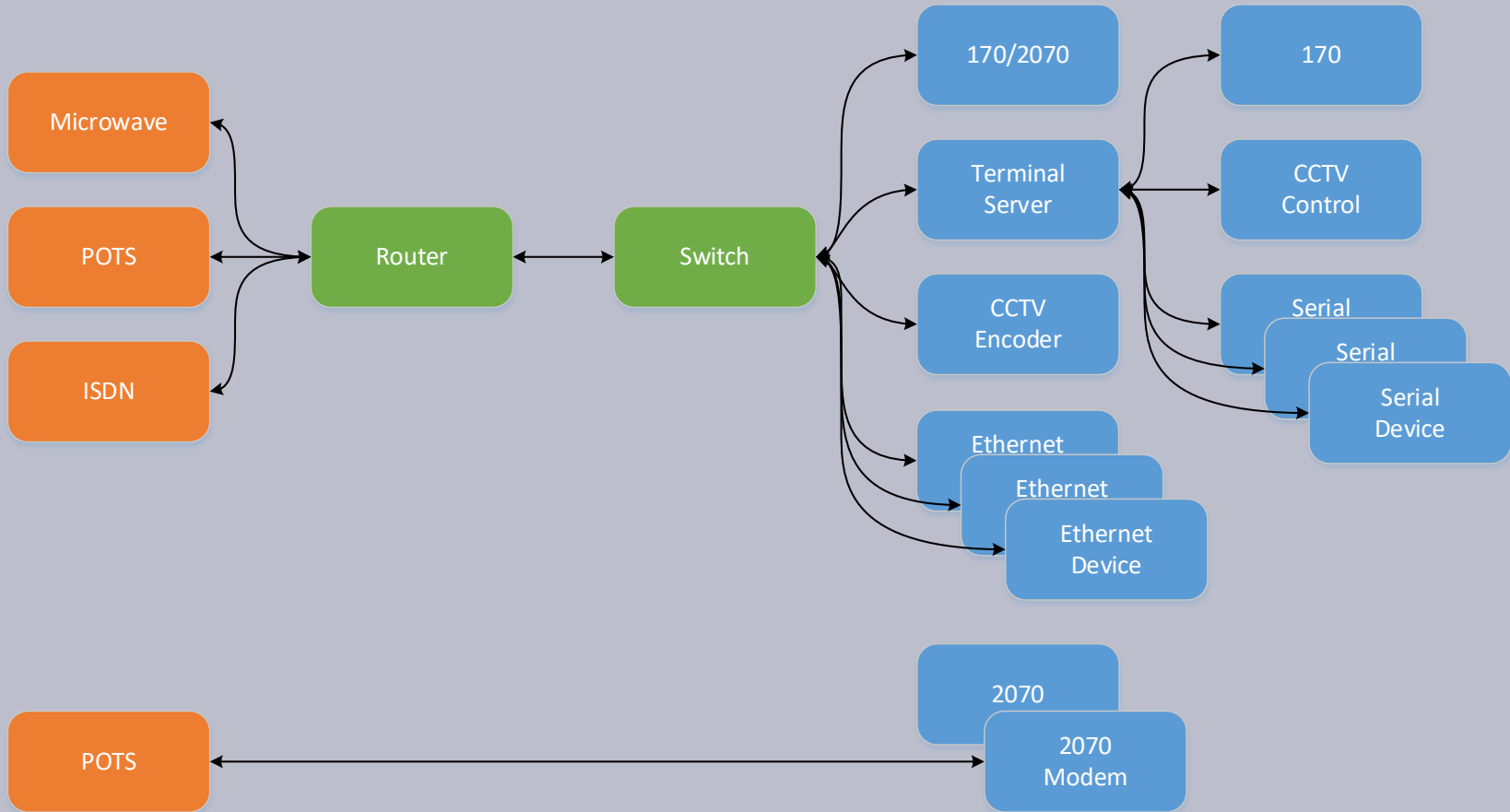
Supported Controllers

- 170E
 - RS-232 (C2 connector)
 - Ethernet Card
- 2070E
 - RS-232/485
 - Ethernet
- AVMS controller
 - Ethernet
- General
 - Serial (RS-232/422/485)
 - Ethernet

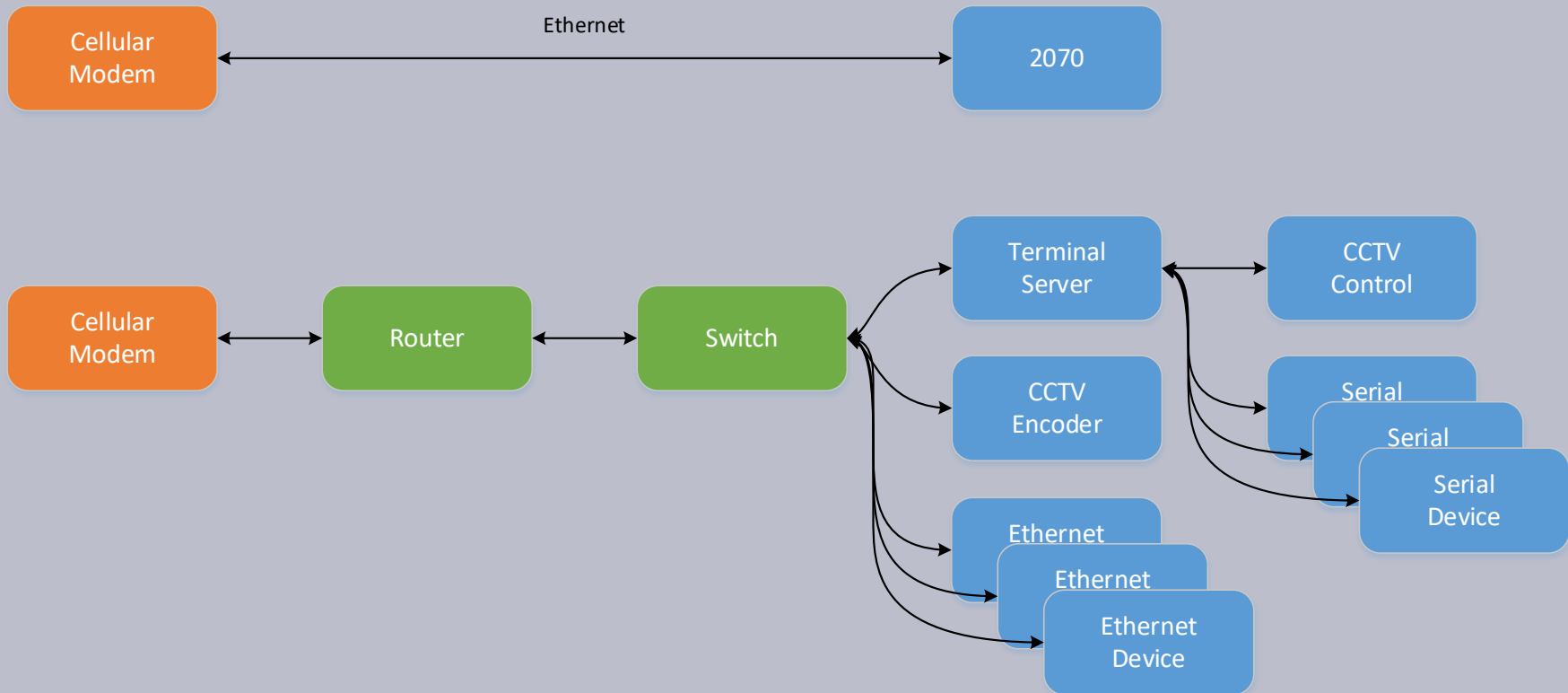
Supported Sign Protocols

- SignView
 - Support 170/2070/AVMS SignView implementations
 - Support all known deployed versions
 - Implementations highly fragmented
 - By device type and version
 - 170 3.x+, 2070 1.x+, AVMS x.y
 - Our implementation based on Caltrans SignView protocol standard
 - Plus support for implementation variances
 - Hardware agnostic
 - Version agnostic
- NTCIP core
 - 1203 v03 standard

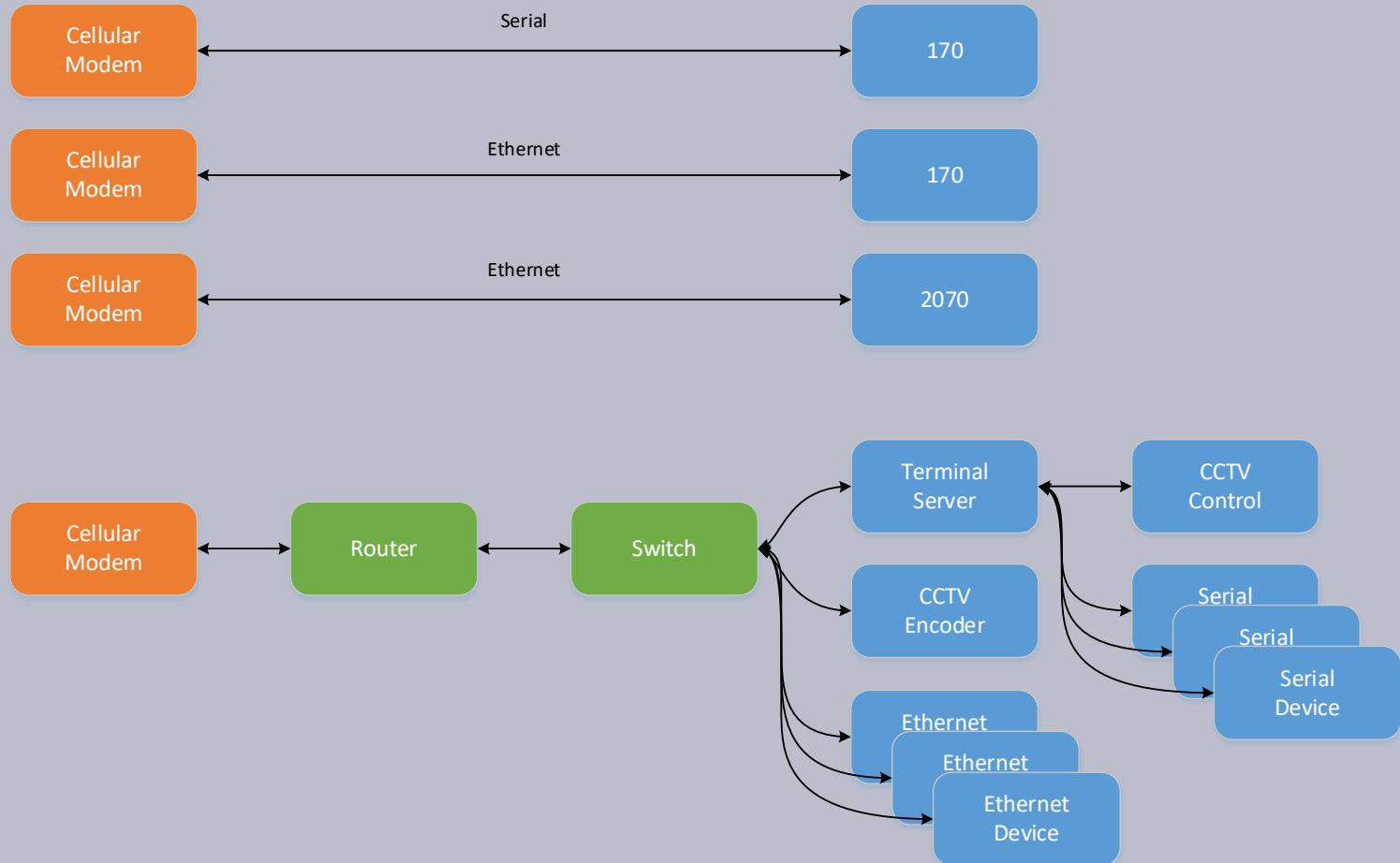
District Configurations (Type A)



District Configurations (Type B)

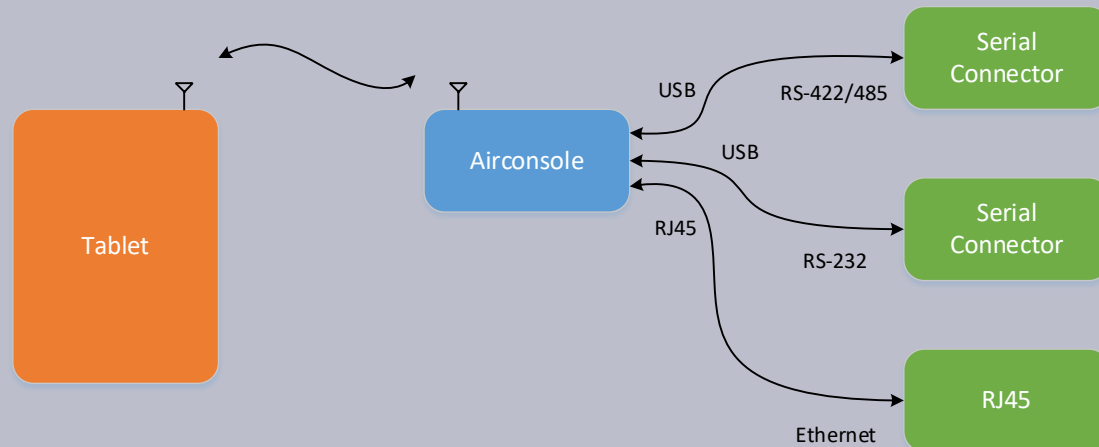


District Configurations (Type C)



Kit Architecture

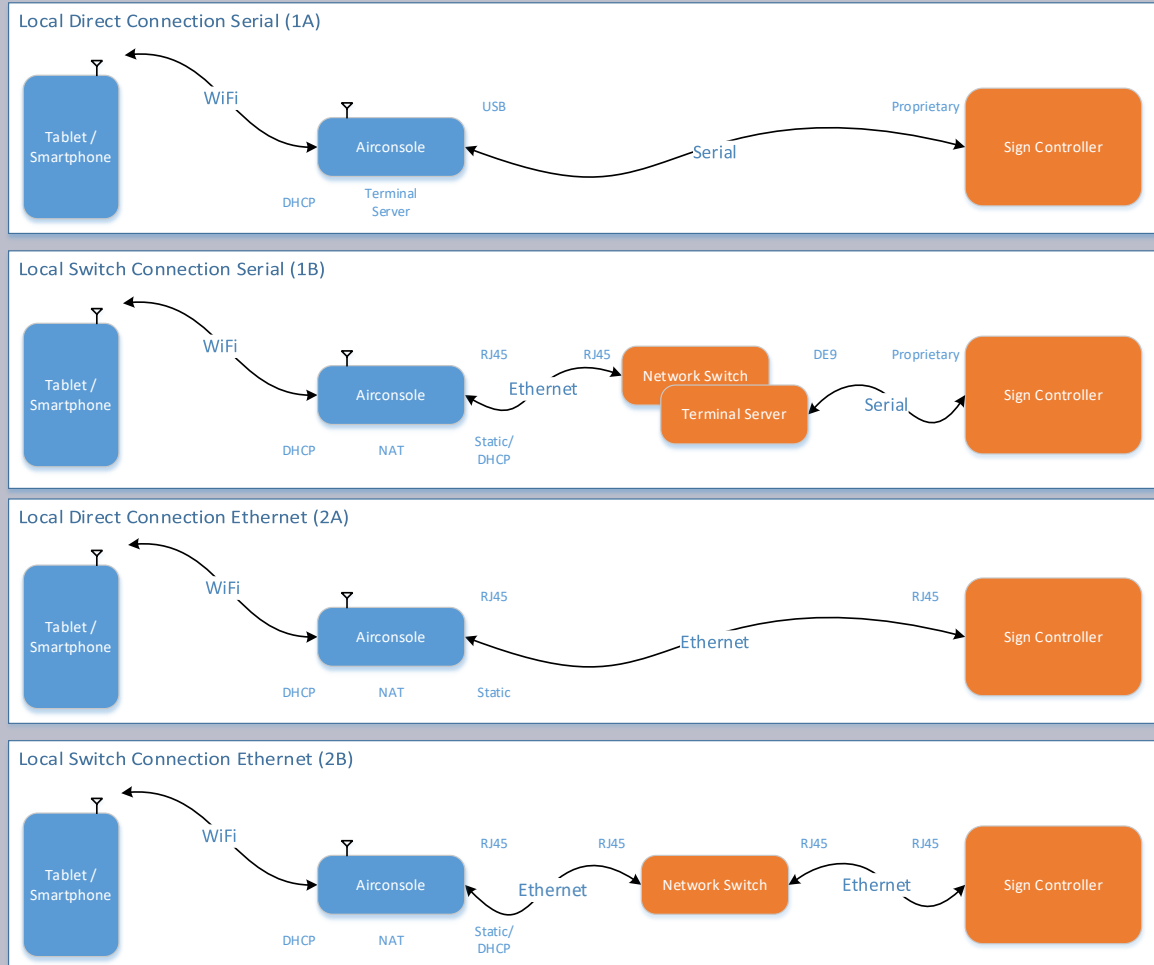
- Tablet
- Wi-Fi to Serial/Ethernet device
- USB to RS-232 serial cable(s)
- USB to RS-422/485 serial cable(s)
- Ethernet cable



Kit Hardware

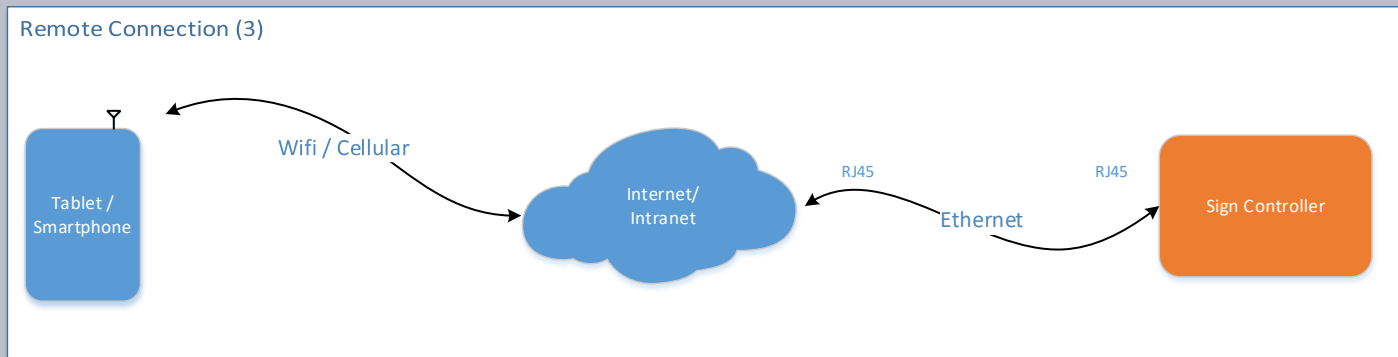
- Pelican Case
- Tablet
- Airconsole XL
- USB 170 C2 (RS-232) Cable
- USB Serial (RS-232/RJ45) Cable
- USB to DE9M RS-232 Cable
- DB9M to DB25F RS-232 Adapter
- DB9M to DB25M RS-232 Adapter
- DB9M to DB9M Adapter
- RS-232 to RS422 Adapter
- RJ45 to DB9F Straight-Through Adapter
- RJ45 to DB9F Cross-Over Adapter
- Ethernet Cable
- Cross-Over Ethernet Adapter
- Chargers
- USB D2 CCTV (RS-422/RJ45) Cable
- USB D6 CCTV (RS-422/DB9M) Cable
- BNC Cable
- NTSC Display

Typical Use Cases

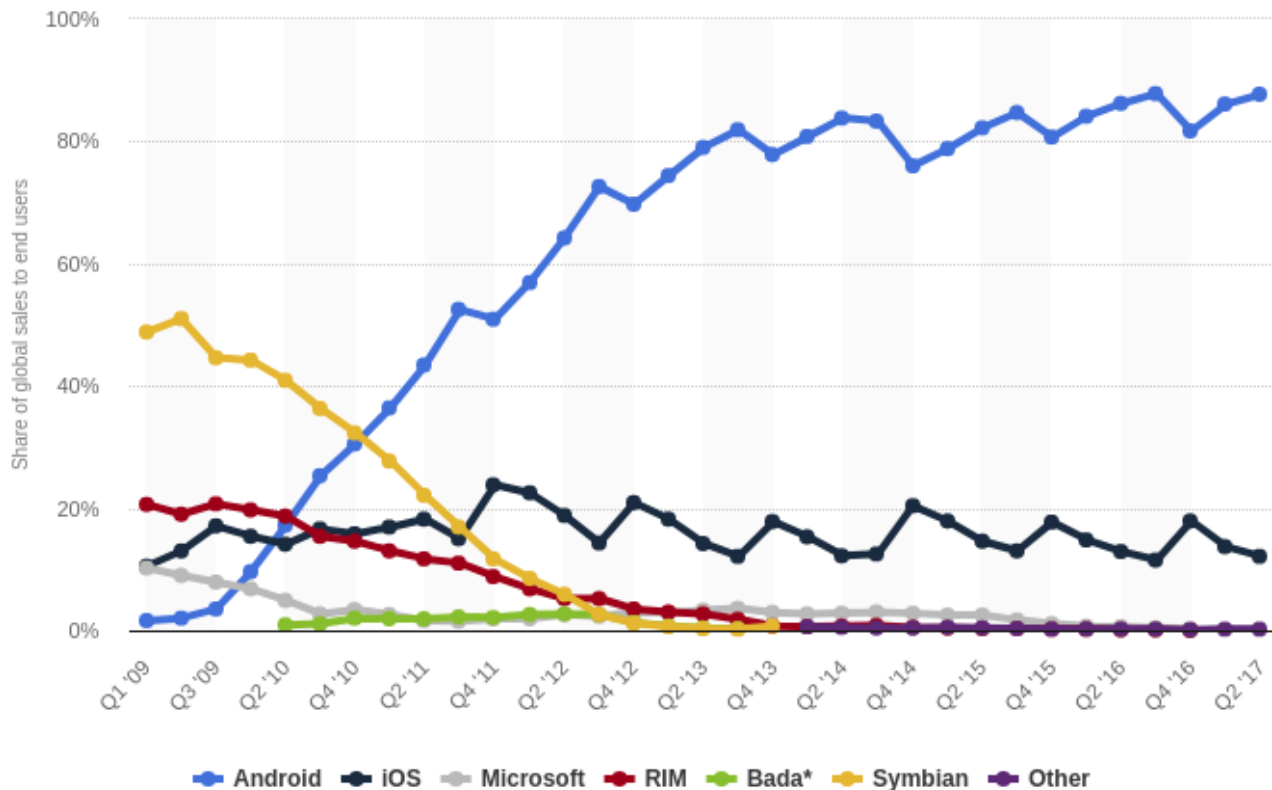


Typical Use Cases

- Depends on field element network visibility



Mobile OS Market Share



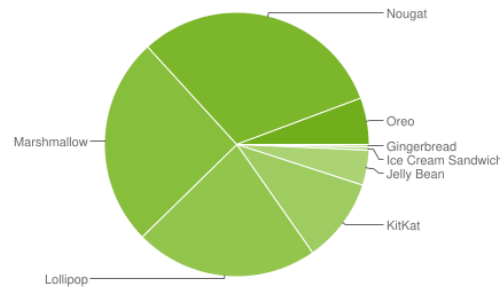
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Additional Information
Worldwide; Gartner

Source
Gartner

Android Version Market Share

Version	Codename	API	Distribution
2.3.3 - 2.3.7	Gingerbread	10	0.3%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	0.4%
4.1.x	Jelly Bean	16	1.5%
4.2.x		17	2.2%
4.3		18	0.6%
4.4	KitKat	19	10.3%
5.0	Lollipop	21	4.8%
5.1		22	17.6%
6.0	Marshmallow	23	25.5%
7.0	Nougat	24	22.9%
7.1		25	8.2%
8.0	Oreo	26	4.9%
8.1		27	0.8%



Data collected during a 7-day period ending on May 7, 2018.
Any versions with less than 0.1% distribution are not shown.

Target Devices

- Android 6.0+
- OS open source (secure, extensible, etc)
- Supported development languages
 - Primarily Java
 - C and C++ support through native development kit (NDK)
 - Kotlin
 - Similar to Swift

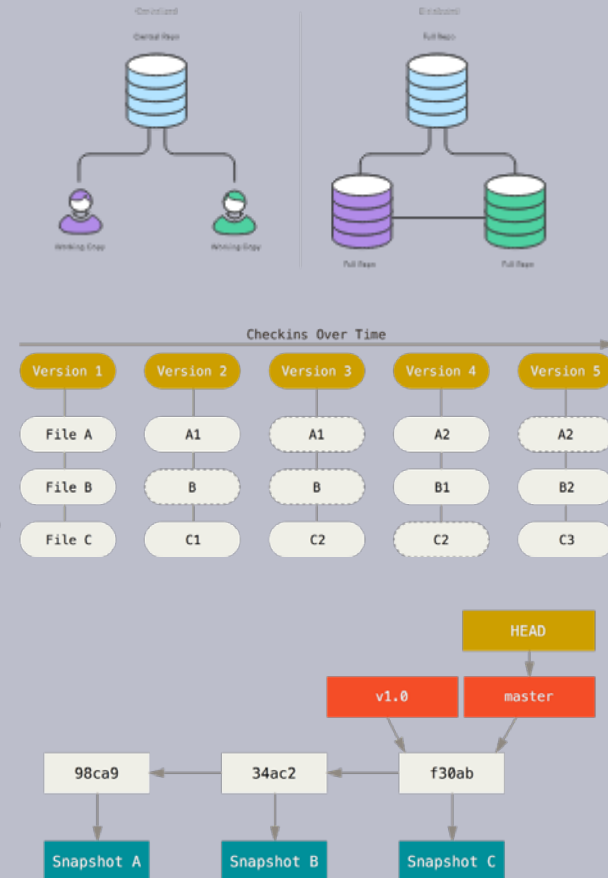
Software Development Environment

- Linux Ubuntu 16.04
- Toolchain
 - Java 8
 - Android SDK
 - Android Studio
 - IDE primarily used for UI layout emulation/evaluation over many devices
 - Android Profiler
 - Gradle (build tool)
 - Command line tools

Code Management

- Git

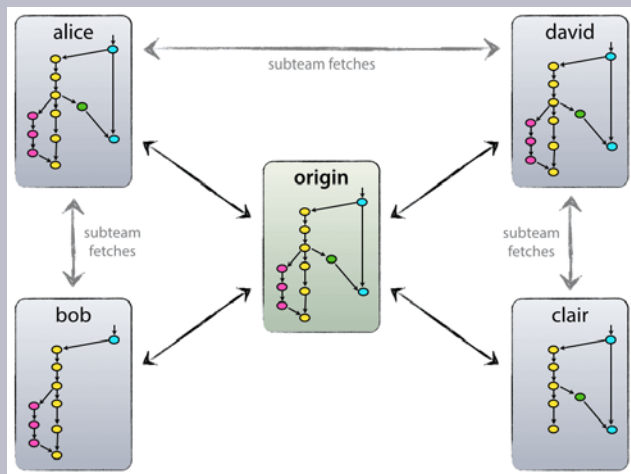
- Fully distributed version control system (DVCS)
- Performance
 - Stores data as series of snapshots, not file plus deltas
 - Nearly every operation is local, avoiding network/server latency
- Integrity
 - Everything is check-summed before being stored (SHA-1)
 - Impossible to make changes to files or directories without Git knowing
- Development
 - Strong support for nonlinear development workflows
 - Git branching model workflow



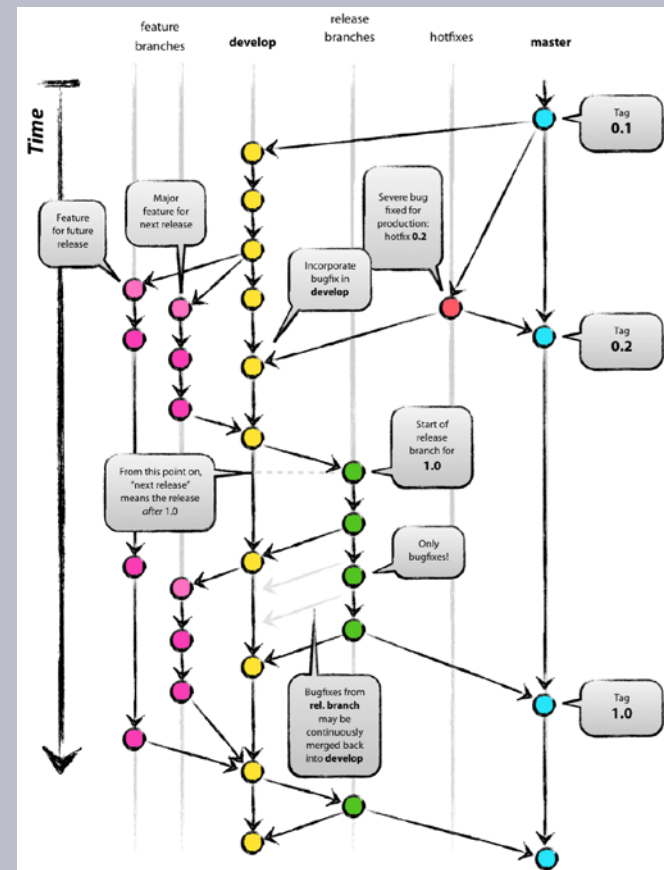
Code Management

Workflow

- Developer pulls origin
- Creates a feature branch
- Commit software changes to branch
- Pushes feature branch to origin
- Makes pull request
- Feature is reviewed and then merged or rejected



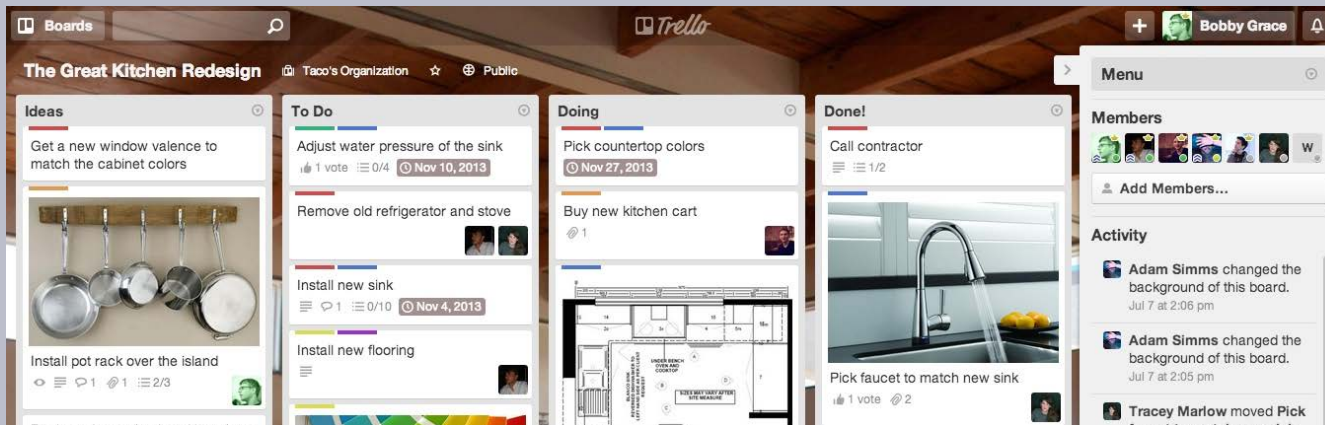
Branching Model



Issue Tracking

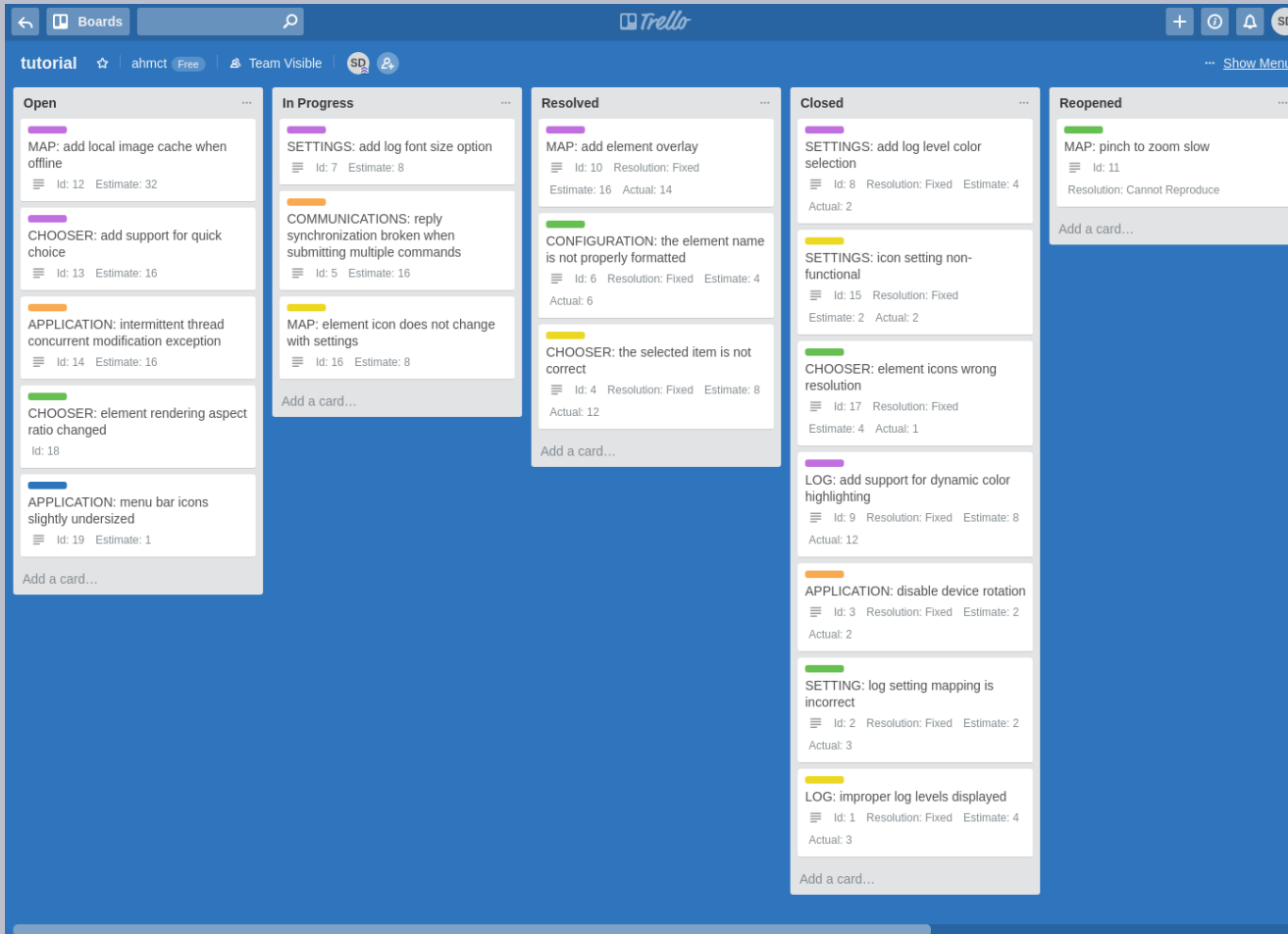
- Trello

- Collaboration tool similar to a whiteboard with lists of sticky notes
- Create custom lists of cards
- Open a card to edit the title or description, add comments, add labels, create checklists, add due dates, or upload attachments



- We developed an issue tracker on top of Trello

Issue Tracking

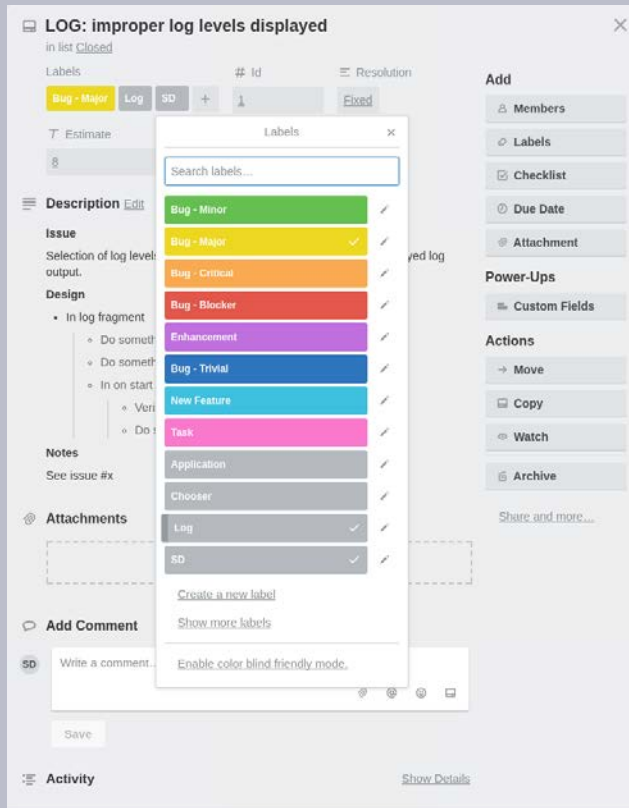


The screenshot shows a Trello board titled "tutorial" with five columns representing different stages of issue resolution. Each issue card includes a title, ID, and estimated/actual time.

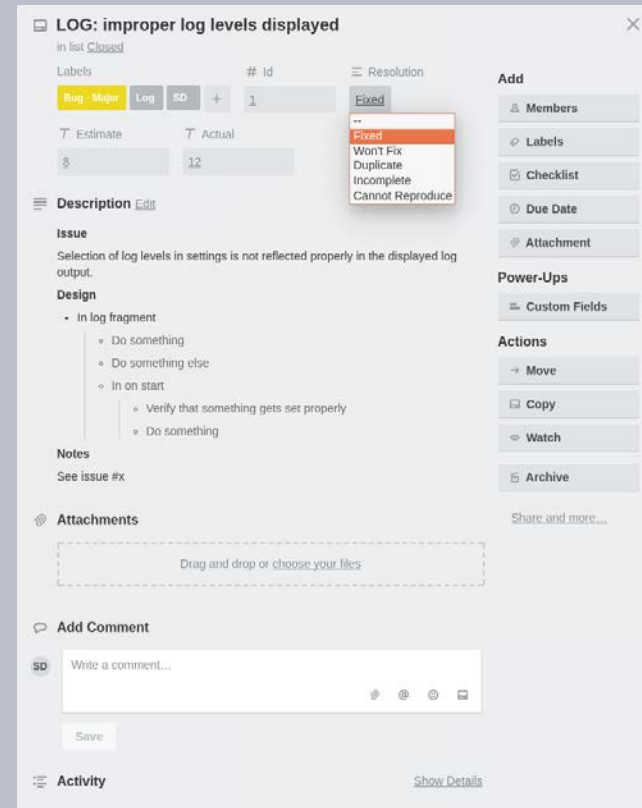
Column	Issue Title	ID	Estimate	Actual	Resolution
Open	MAP: add local image cache when offline	Id: 12	32		
	CHOOSEER: add support for quick choice	Id: 13	16		
	APPLICATION: intermittent thread concurrent modification exception	Id: 14	16		
	CHOOSEER: element rendering aspect ratio changed	Id: 18			
	APPLICATION: menu bar icons slightly undersized	Id: 19	1		
In Progress	SETTINGS: add log font size option	Id: 7	8		
	COMMUNICATIONS: reply synchronization broken when submitting multiple commands	Id: 5	16		
Resolved	MAP: add element overlay	Id: 10	16	14	Fixed
	CONFIGURATION: the element name is not properly formatted	Id: 6	4	6	Fixed
	CHOOSEER: the selected item is not correct	Id: 4	8	12	Fixed
Closed	SETTINGS: add log level color selection	Id: 8	4	2	Fixed
	SETTINGS: icon setting non-functional	Id: 15	2	2	Fixed
	CHOOSEER: element icons wrong resolution	Id: 17	4	1	Fixed
	LOG: add support for dynamic color highlighting	Id: 9	8	12	Fixed
	APPLICATION: disable device rotation	Id: 3	2	2	Fixed
	SETTING: log setting mapping is incorrect	Id: 2	2	3	Fixed
	LOG: improper log levels displayed	Id: 1	4	3	Fixed
Reopened	MAP: pinch to zoom slow	Id: 11			Cannot Reproduce

Issue Tracking

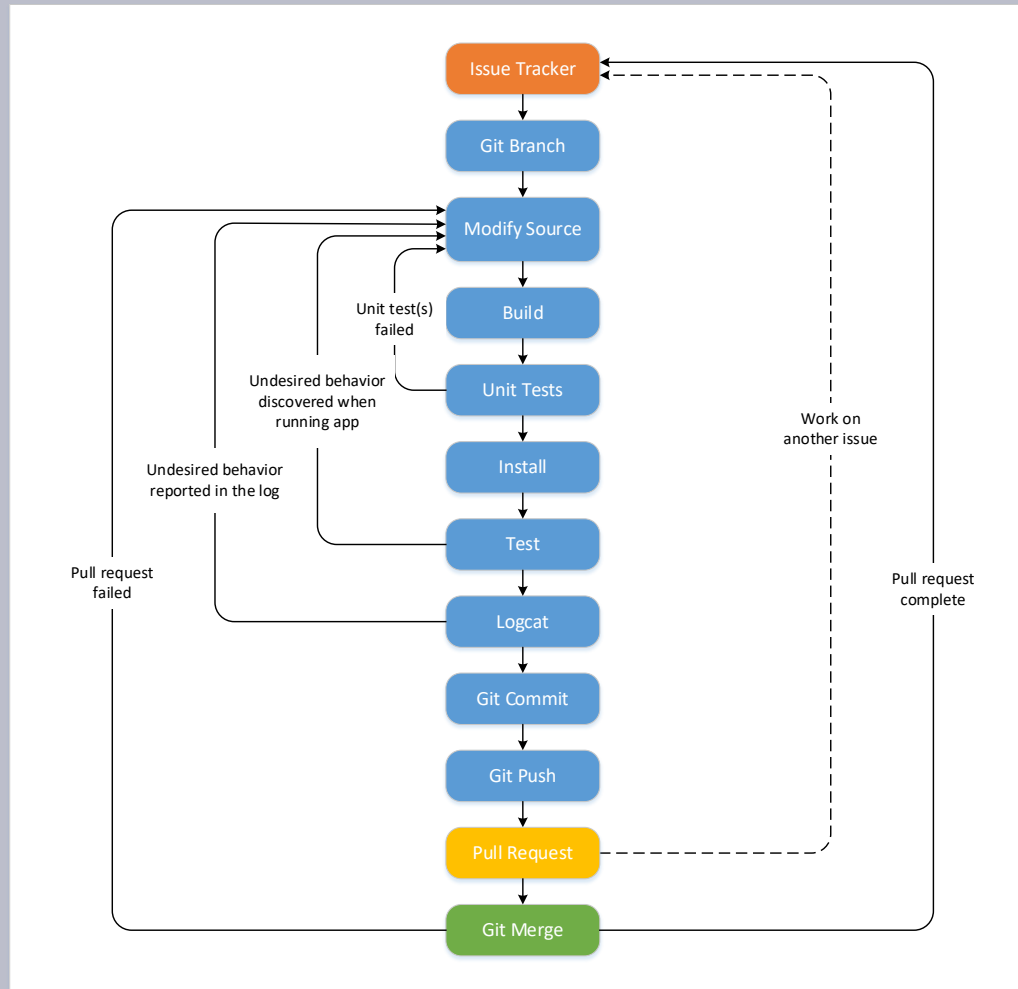
Issue Creation



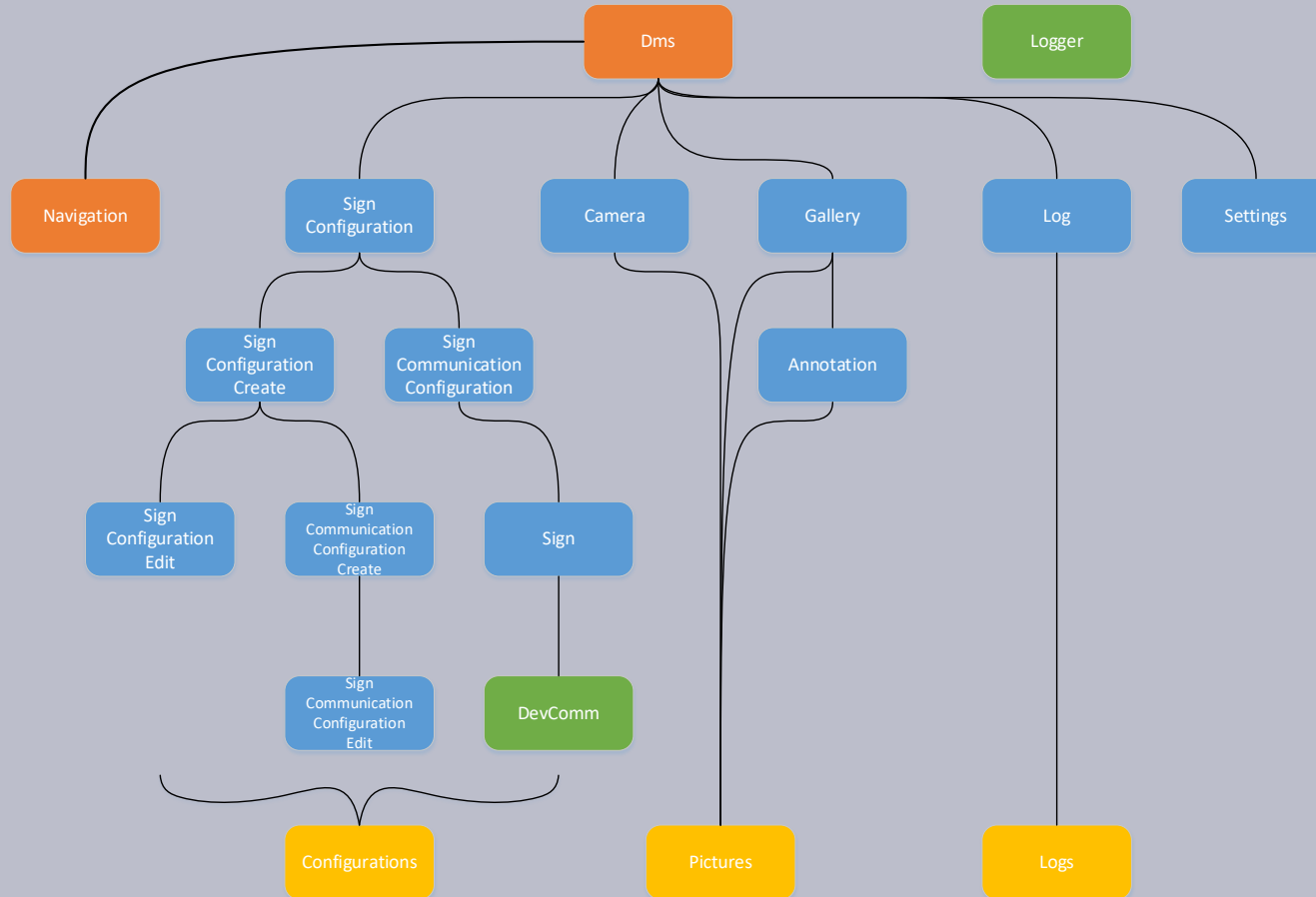
Issue Resolution



Development Workflow



Software Architecture

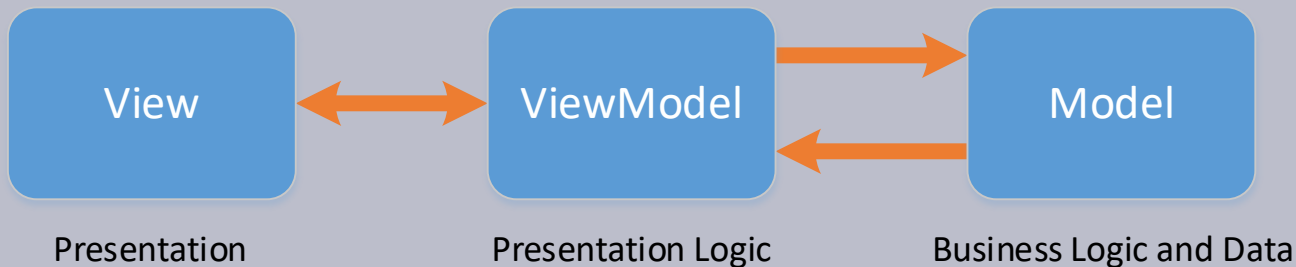


Software Architecture

Pattern MVVM

- Model-View-ViewModel (MVVM)

- **View** is the actual user interface in the app (Activity, Fragment, or Custom View)
- **ViewModel** uses observable data to notify the view about data/state changes, passes events to the model, and converts model data to presentation-friendly data/state
- **Model** is the data classes and the service implementations



Endpoints

- Raw TCP Endpoint
 - Typical host, port, timeout parameters used to establish a data stream over a TCP connection
- Telnet Endpoint
 - Additional timeout parameter, over TCP, used to establish a data stream over a Telnet connection
- RFC2217 Endpoint
 - Additional serial parameters, over Telnet, used to establish a data stream over an RFC2217 connection

Endpoint Parameters

Raw TCP

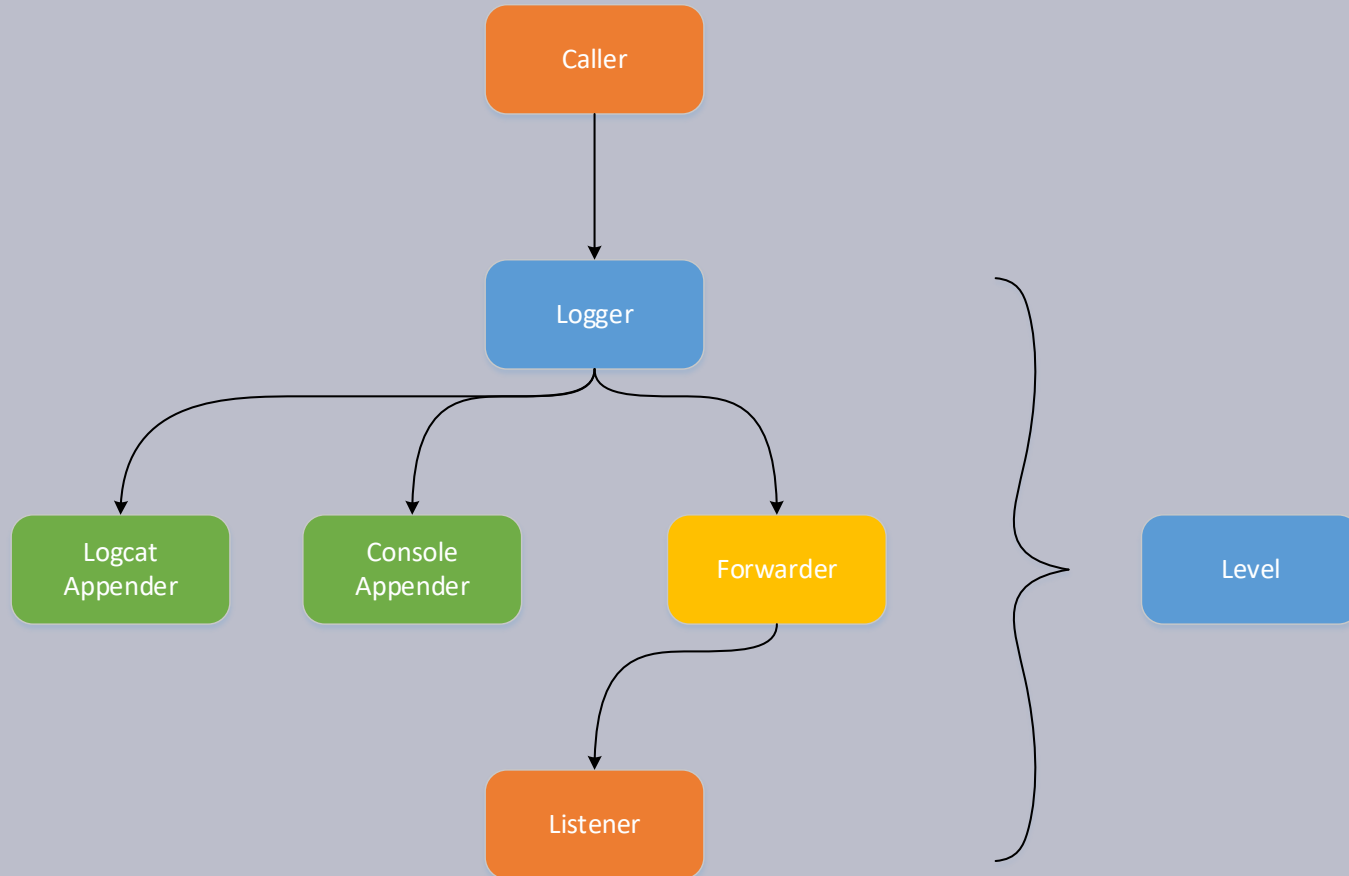
- Host
- Port
- Idle Close Timeout
- Read Timeout
- Connection Timeout
- Socket Timeout

RFC 2217

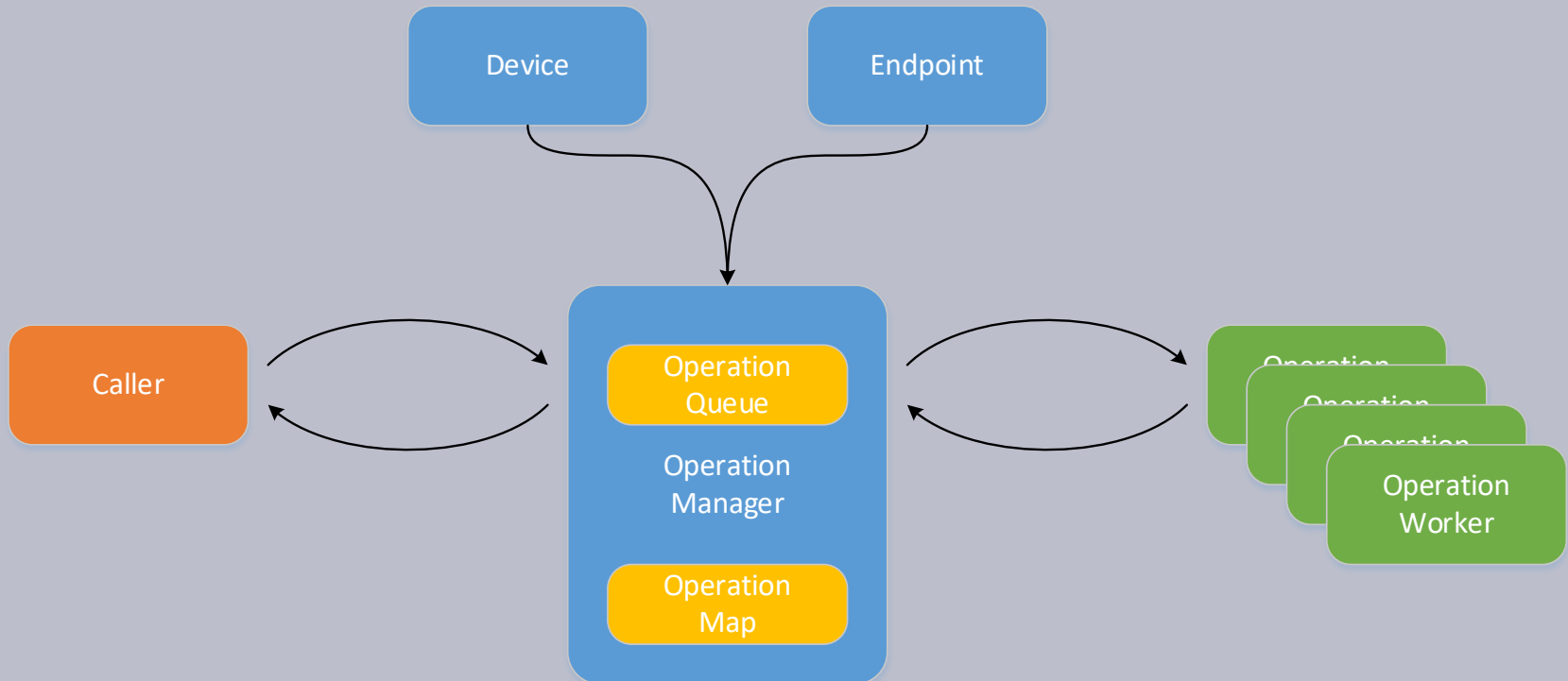
- Host
- Port
- Idle Close Timeout
- Read Timeout
- Connection Timeout
- Socket Timeout
- Acknowledge Timeout
- Baud
- Data Bits
- Parity
- Stop Bits
- Flow Control
- RTS
- Purge Rx
- Purge Tx

Software Architecture

Logger



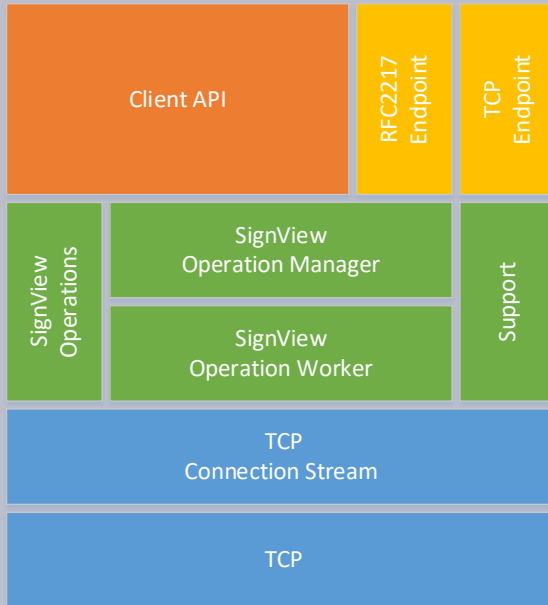
Software Architecture DevComm



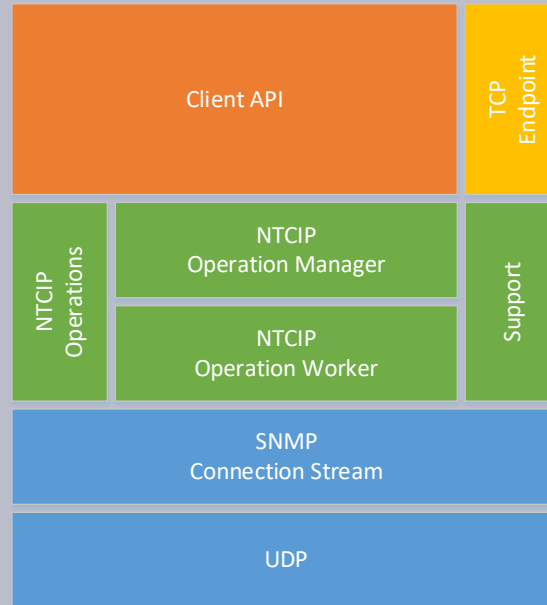
Software Architecture

DevComm Plug-ins

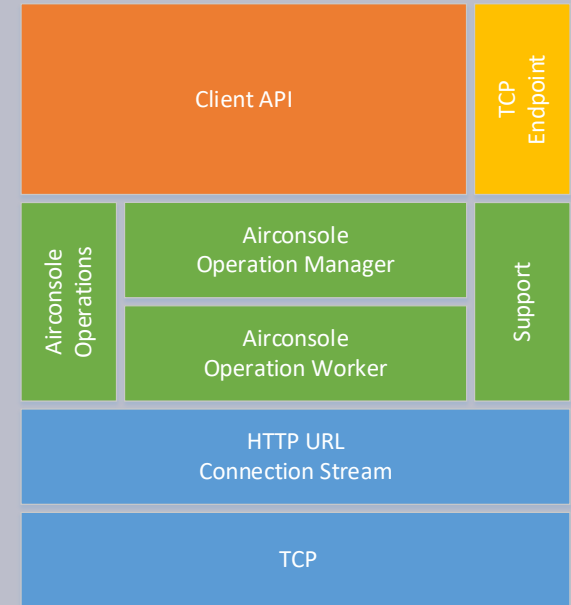
SignView



NTCIP



Airconsole



Extensible

- Modular
 - Well defined interfaces and architecture throughout allow for new developments as necessary.
 - Models
 - Transports
 - Protocols

Data Storage

- Sign Configurations
 - JSON (.json)
 - Primarily (de)serialization of classes
 - SignConfiguration
 - SignCommunicationConfiguration
 - TcpEndpoint
 - Rfc2217Endpoint
 - EXTERNAL_FILES/configurations/dms_signs.json
 - Updated after every modification

Data Storage

- Logs
 - Text (.log)
 - Typical Format
 - Timestamp
 - Level
 - ClassName
 - MethodName
 - Message
 - EXTERNAL_FILES/logs/dms_<timestamp>.log
 - Written on log export

Data Storage

- Images
 - JPEG (.jpg)
 - EXTERNAL_FILES/pictures/<timestamp>.jpg
 - Written on image capture and/or annotation

Code Documentation Guidelines

- General
 - Shall be compatible with Javadoc
 - Shall document all classes
 - Shall document all public and protected fields
 - Should document all private fields
 - Shall document all public and protected methods
 - Should document all private methods
- Class
 - Start the class description with a verb to describe the purpose of the class
 - Never begin description with “This class”, or anything similar

Code Documentation Guidelines

- Class tags
 - @author
 - Use for at least the original creator of the class
 - Subsequent author's contributions may be recorded in the version control system (VCS)
 - @see
 - @since
 - @deprecated
- Fields
 - A field description typically begins with the word “The” followed by a short explanation

Code Documentation Guidelines

- Field tags
 - @value
 - Used to display the value in the description
- Methods
 - Always use a verb to describe the method
 - Constructor - constructs a new ... with the values(s)
 - Setter - sets the something(s) of this thing
 - Getter - returns the something(s) of this thing
 - Setter (boolean) - sets whether this thing is something
 - Getter (boolean) - returns `True` if this thing is something

Code Documentation Guidelines

- Method tags
 - @param
 - The text following the tag should be composed of a noun phrase describing the value represented by the parameter
 - Required for every parameter
 - @return
 - The text following the tag should be composed of a noun phrase describing the value represented by the return value
 - Required unless the method has a void return type
 - @throws
 - The text following the tag should be composed of an “if” followed by a description of the conditions under which the exception is thrown
 - Required for every exception thrown by the method whether checked or unchecked

Code Documentation Guidelines

```
...  
  
/**  
 * A sign communication configuration providing access to the sign name, protocol,  
 * endpoint, and drop.  
 *  
 * @author Stephen Donecker  
 * @company University of California, Davis (AHMCT)  
 * @created January 4, 2018  
 */  
  
public class SignCommunicationConfiguration {  
  
    ...  
  
    /**  
     * Constructs a SignCommunicationConfiguration with the specified name, protocol, endpoint, and drop.  
     *  
     * @param name the name, not null  
     * @param protocol the protocol, not null  
     * @param endpoint the endpoint, not null  
     * @param drop the drop, not null  
     * @throws IllegalArgumentException if the name, protocol, endpoint, or drop are null  
     */  
    public SignCommunicationConfiguration(String name, Protocol protocol, Endpoint endpoint, Drop drop) {  
  
        setName(name);  
        setProtocol(protocol);  
        setEndpoint(endpoint);  
        setDrop(drop);  
    }  
  
    ...  
  
}
```

Code Documentation Guidelines

```
...

/* The endpoint */
private Endpoint endpoint;

...

/** Sets the endpoint of this sign configuration.
 *
 * @param endpoint the endpoint, not null
 * @throws IllegalArgumentException if the endpoint is null
 */
public void setEndpoint(Endpoint endpoint) {

    // check preconditions
    if (endpoint == null) {
        throw new IllegalArgumentException("Sign communication endpoint can not be null");
    }

    this.endpoint = endpoint;
}

/**
 * Returns the endpoint of this sign configuration.
 *
 * @return the endpoint, not null
 */
public Endpoint getEndpoint() {

    return this.endpoint;
}

...
```

Testing

- Typically run tests and monitor logs for results
- Android Profiler
 - Cpu Profiler – inspect CPU usage, thread activity in real-time, and record method traces
 - Memory Profiler – identify memory leaks and memory churn that could lead to performance issues
- Manual Tests
 - Views
- Automated Unit Tests
 - ViewModels
 - Models
 - DevComm
 - DevComm Plug-ins

Problems

- SignView issues
 - Generally
 - Some field controllers incorrectly implement protocol
 - Some field controllers do not implement entire protocol
 - Omissions/errors/ambiguities in protocol specifications
 - Specifics
 - Request Detail TMC Blank Wrong Bytes Remaining
 - Request Detail TMC Blank 0 Byte Payload
 - Request Detail TMC Blank 7 Byte Payload
 - Reply Clipped Tag
 - Request Detail Allow Field Blank
 - Request Detail Field Blank Wrong Bytes Remaining
 - Request Detail Health Check
 - Default to Display Blank TMC 6
 - Allow Reply Pad

Problems

- NTCIP issues
 - Vendor
 - Buggy implementations (i.e. crash if greater than one request per connection)
 - Incomplete implementations
 - Specification Ambiguities
 - Line/page/message scopes for some MULTI attributes
 - Page on/off time edge cases (i.e. [ptx] followed by [ptoy])
 - Minimum spacing between line/page justification regions
 - Pixel rounding in center-justification regions
 - Minimum character spacing in full-justification regions
 - Text alignment when multiple fonts on same line

Problems

- Airconsole provisioning issues
 - All units were factory programmed with the same Ethernet MAC address
 - Shipped firmware version does not support routed mode
 - Configuration
 - Hardware lacking strict API
 - HTML driver
 - Blocking outbound traffic

Looking Ahead

- Additional DMS devices
 - AVMS NTCIP
 - Portable message signs
- CCTV app
 - Supported protocols (PelcoD, CoHu, ONVIF)
 - Real-time video display (video encoders)
 - Fully configurable typical parameters (Pan/Tilt/Zoom, Presets, etc.)
 - Supports test coverage of full command set
 - Import/Export field element configurations
 - Logging, Image capture, etc.
 - Communications (Local/Remote, similar to DMS, RS-422/485, TCP)