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SUMMIT

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San Jose, CA

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# OCP – CBW

# Campus, Branch, Wi-Fi

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Disaggregation of H/W & S/W  
at the edge  
Campus, Branch, Wi-Fi

# OCP-CBW 2017

## H/W (Wi-Fi)

- 5 open source Wi-Fi H/W choices available
  - 3 Broadcom based designs (802.11 AC Wave 1, MIMO)
  - 2 Qualcomm based designs (802.11 AC WAVE 2, MU-MIMO)

## H/W (Branch Switch)

- 2 open source 1Gb PoE Branch Switches

## S/W (NOS)

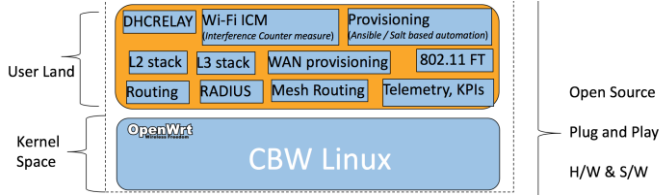
- ONIE support
- Commercial NOS (Mojo Networks)
- Open Source NOS (Network Operating System)
  - CBW Linux (OpenWRT fork)



<http://www.opencompute.org/wiki/Networking/SpecsAndDesigns>

- OCP Accepted™
- Available @ OCP Marketplace
  - <http://www.opencompute.org/products/>

# DevOPs for Wi-Fi



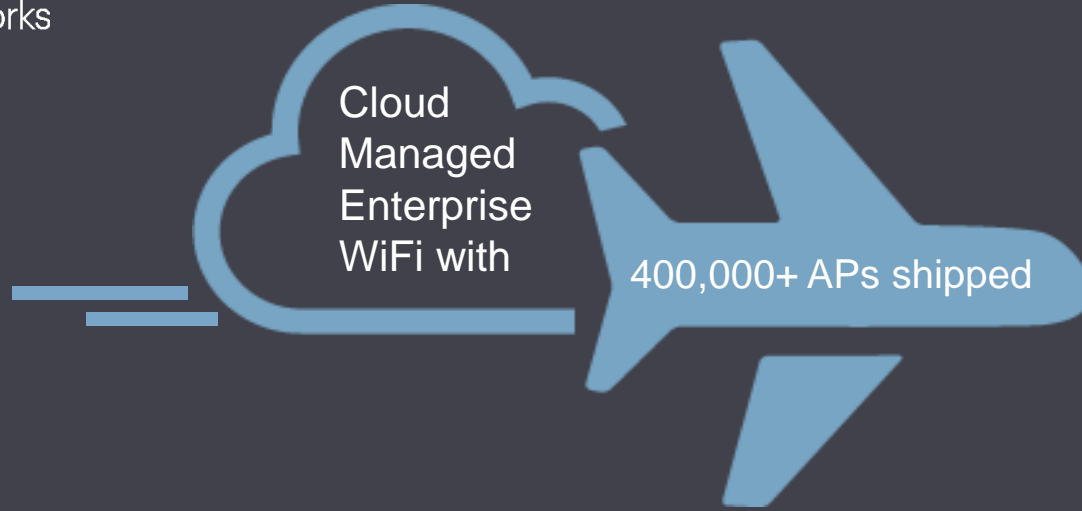


# Walk The Talk: OCP WiFi at US Summit 2018

Sudhan Kayarkar  
Mojo Networks

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## 2500+ customers



## Award-winning Cognitive WiFi™ solution



GARTNER'S  
MAGIC  
QUADRANT



Cloud Disruptor:  
Enterprise

2017 Stratus Awards  
for Cloud Computing



# OCP WiFi at US Summit 2018

- The Case for Hardware-Software Disaggregation in WiFi
- OCP Accepted™ WiFi deployed at US Summit 2018
- “Open AP” adoption in WiFi industry
- Mojo Networks’ efforts to open up the WiFi industry



# The case for HW/SW Disaggregation in WiFi

Same OCP principles that have driven growth for Open Ethernet Switches apply to WiFi Access Points (APs)

- Vendor “Lock In”
  - High deployment cost of APs
  - “Rip-and-Replace” of APs difficult and unfeasible
- High AP HW margins
  - Expensive to buy, implement and operate
  - Value creation primarily in silicon and NOS
- Pace of innovation not meeting market needs

Mojo Networks is committed to leading this Open Standards driven disruption in the WiFi industry

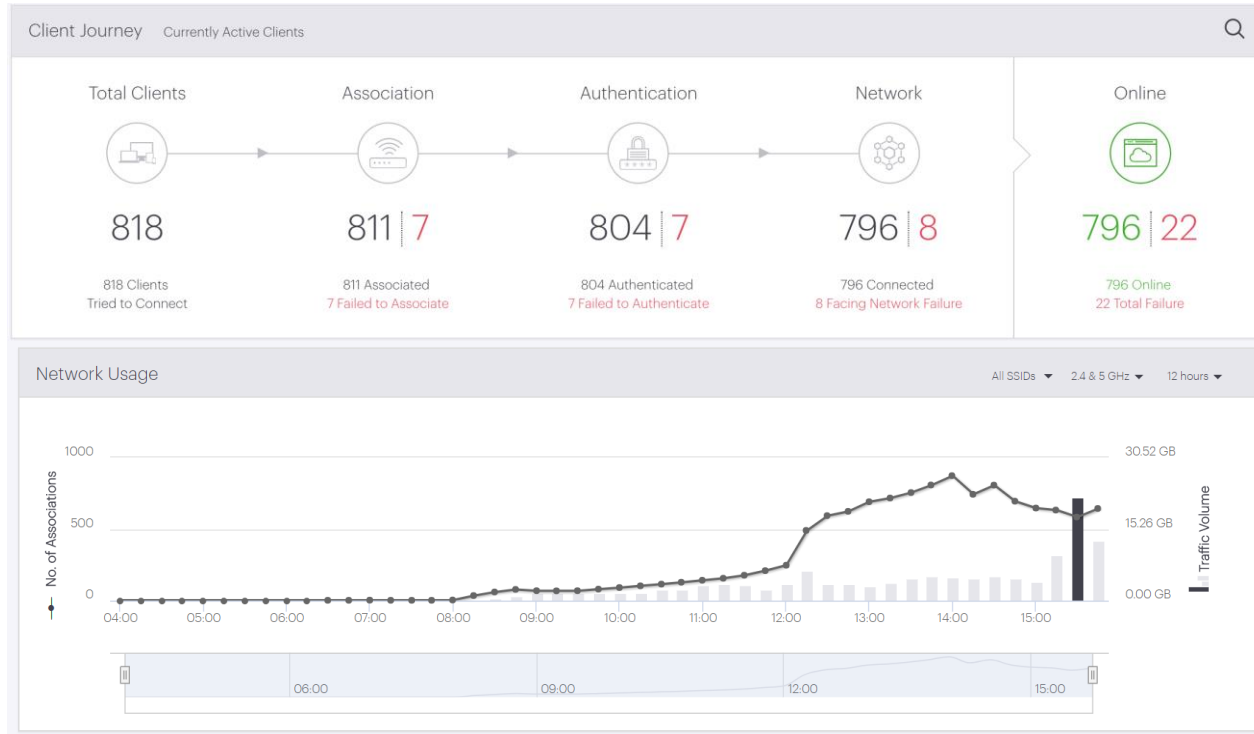
# OCP Accepted™ WiFi at Summit 2018

- 24 APs in Main Expo Hall
- 12 EdgeCore OCP APs ●
- 12 Mojo APs ●
- Demonstrating OCP AP and vendor AP interoperability
- Serving ~3000 attendees
- @ OCP Summit
- SSID: OCP18 or z2.4-OCP18
- Password: SUMMIT2018



Thank you : EdgeCore Networks, FnTech, OCP Summit Org. Committee, NW & CBW groups

# OCP Accepted™ WiFi at Summit 2018



*“We do massive WiFi deployments every week at large scale events and we were pleased with how well this Open WiFi network performed” - Networking Team, FnTech*

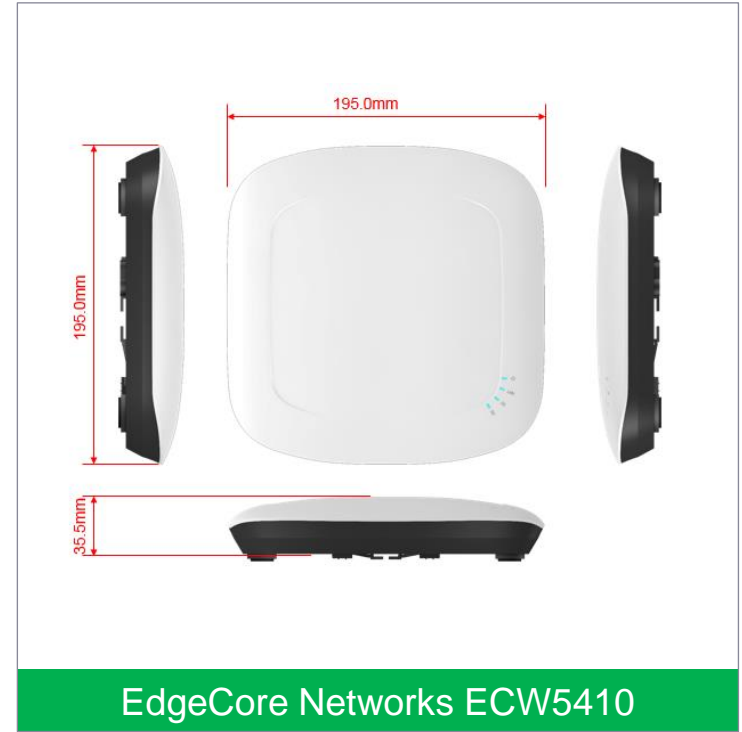
# OCP Accepted™ WiFi Access Point @ Summit 2018

## Hardware

- Qualcomm 802.11ac WAVE-2 4x4 Dual Band Dual Radio
- Submitted to OCP in Mar 2017
- Available @ OCP Marketplace  
<http://www.opencompute.org/products>

## Software

- U-Boot : Version 2012.07
- ONIE partition : ONIE version 2017.02-rc1
- NOS partition : Mojo NOS Ver. 8.6.1; Linux kernel 3.14.77 based on Qualcomm SDK SPF 5.0.2

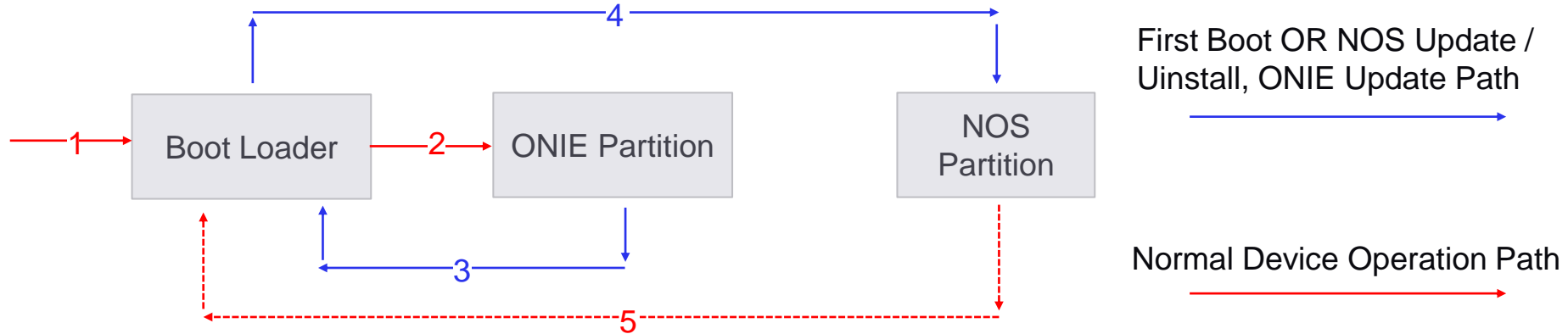


# Learn more about how we did it

- Coming soon: whitepaper detailing the Open WiFi deployment at OCP Summit
  - Planning for interoperable WiFi
  - Technical challenges
  - Testing and validation
  - Lessons learned from the live event
  - Where can the wireless industry go from here?
- Whitepaper will be available at OCP CBW Wiki  
<http://www.opencompute.org/wiki/Networking/CBWCampus2cBranch2CAndWireless>

# ONIE Overview

- Open Network Install Environment (ONIE) defines a dual partition boot mechanism allowing end users to install their Network OS (NOS) of choice



- ONIE Repository and Build system consists of :
  - Platform independent functionality for NOS installer discovery, ONIE update etc.
  - Well defined hooks and mechanisms to add support for a particular platform i.e. Bootloader, Kernel, Ethernet drivers etc.
- Primary adoption has been for ethernet switches within x86 UEFI ecosystem

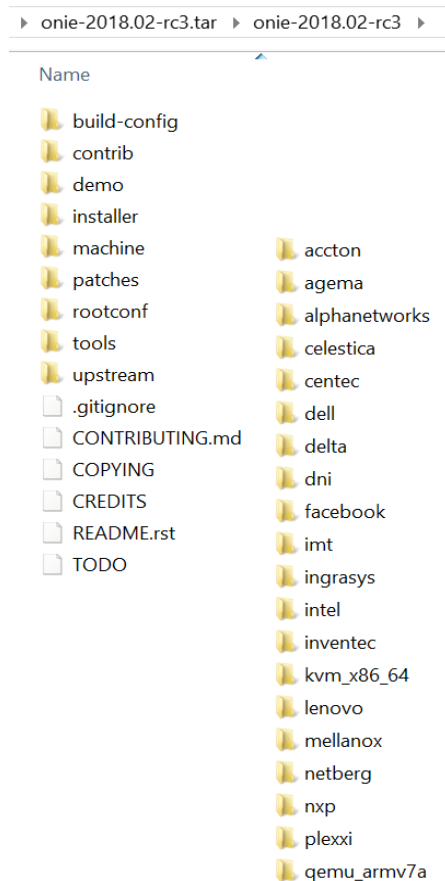
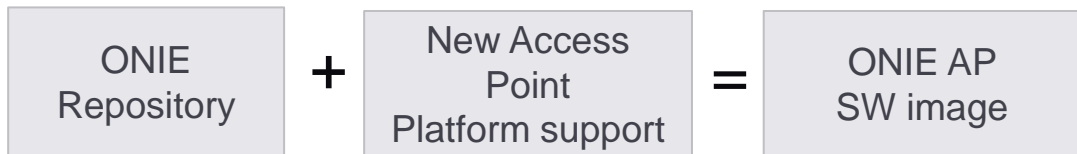
# “Open AP” Adoption in WiFi Industry

	Switches	Access Points
<b>Architecture (ONIE)</b>		
CPU	Mostly x86 & ARM-64	Mostly ARM-32; some MIPS, PowerPC
Bootloader	Unified Extensible Firmware Interface (UEFI)	U-boot or proprietary
<b>Security (ONIE)</b>	Current ONIE Secure Boot Proposal based on x86 UEFI ecosystem	<ul style="list-style-type: none"><li>• CPU specific secure boot mechanisms. eg. ARM TrustZone™</li><li>• Trust Platform Module (TPM) HW may or may not be present</li><li>• NOS vendor key management</li></ul>
<b>Wireless Certifications</b>	Not applicable	Cannot ship without necessary regulatory wireless certifications

# ONIE on WiFi Access Points: Architecture

## Approach A

### Add ONIE build option to chipset SDK



Working with chipset vendors to open source patches and components of licensed chipset SDK

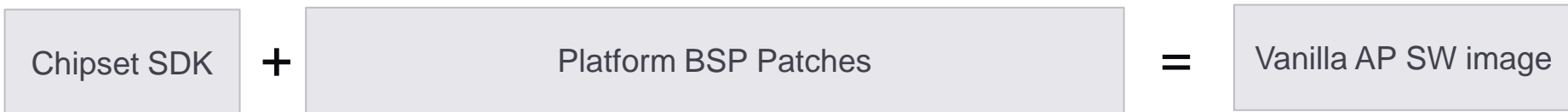


# ONIE on WiFi Access Points: Architecture

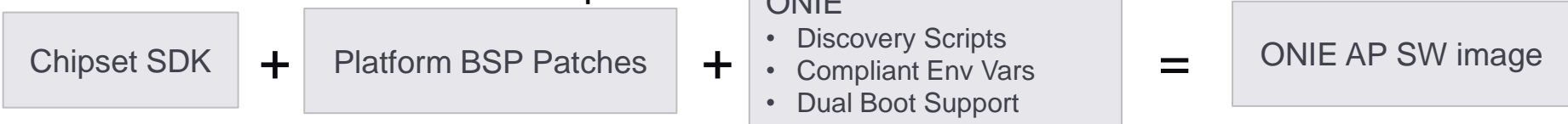
## Approach B

### Add ONIE build option to chipset SDK

#### Normal SDK build



#### Modified SDK with ONIE build option



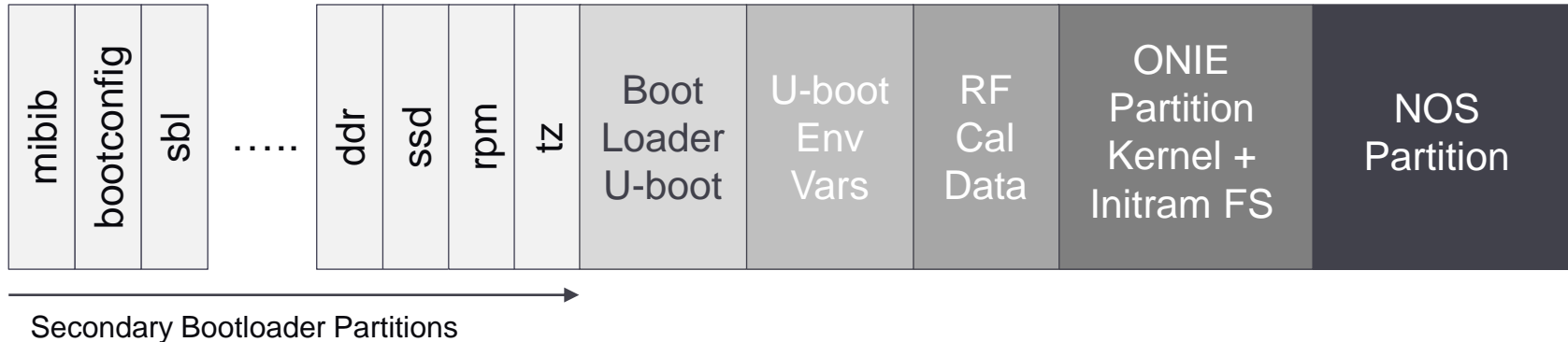
- No licensing issues related to chipset SDK
- Scalable. ONIE build available immediately for every chipset reference platform
- Lowers adoption barrier for HW vendors; leverages familiarity with chipset SDK
- Enables ONIE and chipset SDK development to happen in parallel

# ONIE on WiFi Access Points: Architecture

## Summary

- Approach A : Adding Access Point platform support to ONIE
  - Enable HW vendors to submit patches for their Open APs to ONIE repository
- Approach B : Add ONIE build option to chipset SDK
  - Enable HW vendors to generate ONIE builds from Chipset SDKs for their Open APs

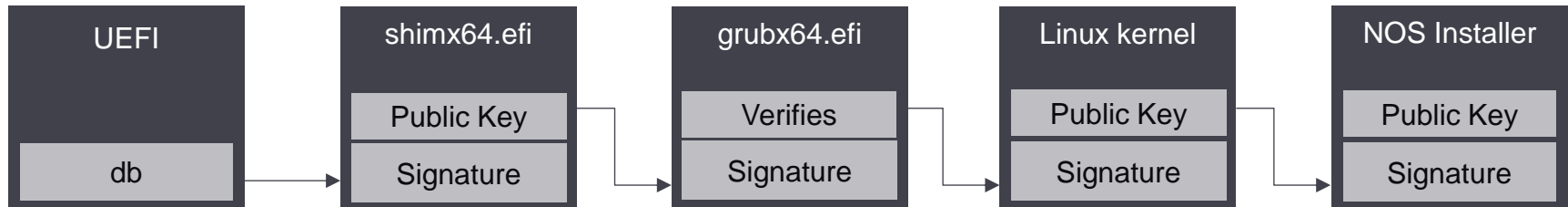
Both options could co-exist



Logical Flash Partition Layout on a Qualcomm ARM AP platform

# ONIE Secure Boot for x86 platforms

- Utilizes UEFI mechanisms
- Establish “root of trust” in HW and Boot Firmware; extend “chain of trust” along boot path
- Components
  - UEFI and databases
  - Shimx64.efi
    - Thin EFI application, typically signed by Microsoft, contains shim owner’s embedded public certificate
  - MokManager.efi
    - Machine Owner Key (MOK) database
    - Allows Enrolment / Removal of NOS Installer / Image keys



Source : ONIE UEFI Secure Boot proposal, Curt Brune

# ONIE on WiFi Access Points: Security

- Today, AP vendors implement some sort of verification of signed images to restrict flashing of arbitrary images on their APs.
- U-boot supports “verified boot” starting version 2013.07
- Vendor’s certificate public key is stored in an OTP partition
- Leverage mechanisms like ARM TrustZone™
- Maintaining NOS vendor key databases within the AP SW/HW ecosystem is the main challenge

# ONIE on WiFi Access Points: Security

## NOS Vendor Key Management Possibilities

- PKI system involving HW and NOS vendors
  - HW vendor generates root CA and programs certificate hash in OTP ROM.
  - NOS vendors get derived CAs from HW vendor's root CA to sign their NOS images
- Port UEFI to AP HW/SW subsystem and follow the ONIE Secure Boot model
  - UEFI support in u-boot
    - Work in progress (SUSE Linux)
    - EFI variables required for key database management; unclear if supported
  - UEFI on ARM
    - Targeted for Server market to bring uniformity between x86 and ARM
    - May be too disruptive to existing WiFi AP SW ecosystem

# “Open AP” Adoption in WiFi Industry: Certifications

- Access Points cannot ship without necessary regulatory wireless certifications
- Possible solution
  - OCP Acceptance to include regulatory certification
  - Approved regulatory domain power tables published for an Access Point must be adopted by NOS vendors
  - Need a model to distribute certification NRE costs that is fair to all
  - Should ONIE for Access Points include WiFi subsystem ?
- FCC does not currently support a certification model that recognizes HW / SW disaggregation
- “RF Calibration Data” partition (unique to an Access Point) must be maintained intact throughout operational lifetime

# Bringing Disaggregation benefits to Mojo customers

Open Standards are a core belief at Mojo Networks

They are also a fundamental piece of our business strategy

1. Make APs available at “factory costs” with no margin for Mojo
  - Complete, April 2016
2. Get zero margin hardware out of our financials
  - Complete, December 2016
3. Collaborate with OCP.
  - Leverage ONIE to enable end users to install NOS of choice on their APs
  - Continuing to make progress

# Leading the Cognitive WiFi revolution

[www.mojonetworks.com](http://www.mojonetworks.com)







# OCP SUMMIT