Ericsson Carrier-Grade WiFi Solutions
Increase of Mobile Traffic (global)

'Traffic' refers to aggregated traffic in mobile access networks. DVB-H and Mobile WiMax or WiFi traffic have not been included. M2M traffic not included.
From - WiFi Off-load

Today: WiFi network operates independent of cellular network. Handset decides when to move to WiFi.
WiFi Small Cells - TODAY

Data rate [Mbps] vs. Generation

Cellular

Today

WiFi
To – Add WiFi Spectrum
Integrated 3G/4G/WiFi networks

IMPROVE

Wanted:
Network based access selection based on:
- Policies
- Application
- Subscription
- User speed
- Radio characteristics

Requires:
- Core integration
- Scalability
- User experience improvements

ADD

DENSIFY

Required Capacity
Current Capacity
WiFi Small Cells - Wanted

Data rate [Mbps]

Cellular

Wanted

WiFi
Understanding Carrier-grade WiFi

› Carrier-grade WiFi is NOT:
  – An alternative to cellular infrastructure
  – Enterprise WiFi technology

› Carrier-grade WiFi is:
  – Part of a carrier’s heterogeneous network strategy
  – Small cell technology for indoor and outdoor networks
  – Targeted at improving the mobile broadband user experience and supporting new business models
  – A global opportunity
Small Cells for Heterogeneous Network

- AP6000 (WiFi)
- mRRUS12
- mRBS
- pRBS
- Indoor Pico Gateway
Pico RBS – Indoor and Small Cells

› pRBS
  – 2 x 1W with MIMO
  – Built-in WiFi AP
  – LTE and 3G supported
  – Built-in antennas
  – VDSL2, WiFi etc. for access

› Indoor Pico Gateway
  – Indoor RBS gateway
  – Opto/electric Ethernet or VDSL2 for access to pRBSs
  – Full co-ordination with macro layer
Ericsson WiFi Portfolio

ACCESS POINTS

BelAir100NE Series
Outdoor High-Performance AP
Strand / Wall / Pole / Vault
Cellular Co-location

BelAir 20E/ 20EO / AP5100 Series
Cost-Effective Indoor/Outdoor Hotspot

Scalable, Carrier-Centric BelAirOS
Proven Reliable and Secure

CONTROLLERS

WiFi Controller
(WIC8000)
Stackable, Pooled

Innovative Carrier-Centric Design, Provides Deep
Client Insights/Optimizations

MANAGEMENT SOFTWARE

WiFi Manager
GIS-Oriented, Realtime
Carrier-Scale FCAPS

WiFi Analyzer
Service Delivery Management

Reliable Platforms and Tools
Designed for Carriers and
Optimized for Agility and Scale
End to End WiFi Solution

Internet

Mobile Packet Core
- Broadband GW (SSR)
- PDN-GW (EPG)
- SAPC/IPWorks
- HLR

Radio Access Network
- 8000 Data Center Controller
- Wn, L2overL3
- GTP (S2a)
- Wa
- Wn

Applications
- Call Site Co-Lo/Underlay
- City Hotzone (Mesh)
- City Hotzone (HFC)
- Large Venue
- Small Venue

Users
- iPhone
- iPad
- Tablet
- Laptop
- Gaming Console
- Camera

Management
- WiFi Manager
- BelAirOS

Operating System
- Business Intelligence

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Belair OS

CARRIER GRADE ACCESS POINT OPERATING SYSTEM

› Common platform for all Ericsson WiFi access points
› Universal software across all platforms and generations
› Carrier-grade performance and reliability
› Clear, consistent architecture enables fast development
› Bridge/SSID virtualization maximizes service flexibility
› Realtime reporting enables accurate management
Belair 20E / 20EO / AP 5100 Series

COST-EFFECTIVE INDOOR/OUTDOOR WIRELESS ACCESS POINT

› Common radio platform for all BelAir 20E and 20EO products
  - BelAir 20E
  - BelAir 20EO A/B/C/D
  - AP 5114

› Concurrent dual-radio architecture
› 2.4 GHz IEEE 802.11 b/g/n certified
› 5 GHz IEEE 802.11 a/n certified
› Each radio supports full 2x2 MIMO with 2 spatial streams
› Peak throughput of 150 Mbps per stream, 300 Mbps per radio
› Peak throughput of 600 Mbps per access point
› Standards-based IEEE 802.11n-2009 beamforming
› Space Time Block Coding (STBC) for improved receive sensitivity
› Improved Maximum Ratio Combining (MRC) for better terminal performance
› Supports Passpoint (Hotspot 2.0) including 802.11u for seamless secure roaming
Belair 100ne Series

HIGH-PERFORMANCE OUTDOOR WIRELESS ACCESS POINTS

› Concurrent dual-band 2.4 GHz and 5 GHz operation
› Each band uses 3x3 MIMO with 3 spatial streams
› Transfers up to 900 Mbps per access point
› WiFi Alliance Certified 802.11 a/b/g/n
› Beamforming per IEEE 802.11n-2009 standard
› -101 dBm receive sensitivity
› 36 dBm EIRP transmit power
› Space-Time Block Coding for increased terminal performance
› Improved Maximum Ratio Combining for best in class receive sensitivity
› Supports Passpoint (Hotspot 2.0) including 802.11u for seamless secure roaming
› Integrated GPS for accurate location
› Immunity to nearby microcells
WiFi Controller 8000 (WIC8000)

Manages, controls, and aggregates traffic from clusters of subtended access points in permanent or temporary / special event locations

Stackable, scalable hardware configurations
WiFi Controller 8000 (WIC8000)

FEATURES AND BENEFITS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
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<tbody>
<tr>
<td><strong>Management</strong></td>
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<tr>
<td>Management proxy between WiFi Manager and access points</td>
<td>Improves scalability</td>
</tr>
<tr>
<td>Data collection from subtended access points</td>
<td>Enables network-wide performance monitoring and optimization</td>
</tr>
<tr>
<td>CAPWAP encrypted protocol to access points</td>
<td>Secure, standards-based</td>
</tr>
<tr>
<td><strong>Mobility</strong></td>
<td></td>
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<tr>
<td>Proxy Mobile IP, L2VPN, GRE northbound mobility tunnel termination</td>
<td>Enables wide-area mobility in core</td>
</tr>
<tr>
<td>Subscriber mobility between subtended access points</td>
<td>Efficient mobility within access network</td>
</tr>
<tr>
<td><strong>Aggregation</strong></td>
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<tr>
<td>Traffic aggregation for subtended access points</td>
<td></td>
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<tr>
<td><strong>Security</strong></td>
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<tr>
<td>Policy enforcement</td>
<td></td>
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<tr>
<td>Caches credentials from policy manager</td>
<td></td>
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<tr>
<td><strong>Applications</strong></td>
<td></td>
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<tr>
<td>Video optimization support</td>
<td>Content delivery optimization</td>
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</tbody>
</table>
WiFi Manager

NETWORK MANAGEMENT SYSTEM

- Tiered architecture scales to 100K access points
- Tile-based mapping in GIS-centric graphical interface
- Retrieves real-time data including client device location and system status
- Color coded nodes based on multiple parameters for trend analysis and troubleshooting
WiFi Manager

NETWORK MANAGEMENT SYSTEM

› Next generation integrated GIS and NMS system
› Tile based live maps
› Auto places nodes on map
› CLI and Web GUI
› Fast view response
› Visualization layers
› Color coding
› Statistics
› Plots
› Alarms
› SNMP
WiFi Analyzer

SERVICE-LEVEL PERFORMANCE MONITORING

› Web-based executive dashboards
› Business analysis optimized for offload
› Usage information data collection from WiFi Manager
   - Bytes, Sessions, Minutes, Users
   - 1 day / 7 days / 30 days / 90 days views
   - Top Access Points – list and map
   - Traffic per SSID, per network
› Identification of high-usage locations and user behaviour trends
› Intuitive Google-based visualizations
› Drive investment decisions for optimal ROI
VHCI Environments
Very High Capacity & Interference

Worst cases for WiFi
Important Aspects of VHCI Features

**DROP USELESS PACKETS**
- Broadcast filtering
- DHCP/ARP control
- Home protocol block

**SHARE BANDWIDTH**
- Prioritize high-rate Mod.
- Backhaul traffic limiting
- VLAN / User-based QoS

**IGNORE WEAK CLIENTS**
- RSSI packet filter
- Client RSSI threshold
- Modulation rate control

**MANAGE RADIO RESOURCE**
- Tx Power Management
- High-rate RTS-CTS
- CTS-to-self control
- Collision control

**BALANCE CLIENT LOADING**
- Band-steering
- Fuzzy client limits
- AC-driven balancing

**REJECT INTERFERENCE**
- Weak signal ignore
- Cellular rejection filter
Stadium Bowl WiFi Network Design

- 3 channels re-use pattern
- Directional antenna (20 degrees beamwidth)
- Antenna tilted towards first seat in the coverage
The Largest Mobile WiFi Networks in the World

- 3000+ sq km
- World’s Most Commercially successful WiFi network
- Largest WiFi network in the world
- Full IP and session Mobility
- Multi-Service using Virtual AP
- Centralised Authentication
- Powered By Ericsson
WiFi Controller

- **WiFi Controllers**
  - S1/Iub/Abis
  - S1/Iub CAPWAP
  - CAPWAP
  - L2/L3 + GTP Legacy
  - GTP(S2a)
  - EVO
  - EPG (PGW)
  - Local Breakout
  - - Fixed/Cable
  - - Residential
  - - WiFi/4G
  - - 2G/3G/4G/WiFi
  - - Optimized HetNet
  - - Distributed deployment

- **pRBS**
- **AP**
- **WIC8000**
Evolution of Operator WiFi Solutions
from access control to mobility

Now
Static WiFi access control
• Max # users / AP
• Received signal power threshold

Next Step
Semi-dynamic WiFi access control
• Load in 3GPP overlapping cell
• Load in WiFi
• Policies per subscription
• Heterogeneous Networks
• HS2.0 & ANDSF

Future
Mobility
• Full Coordination with 3GPP
Ericsson Network Integrated WiFi (ENIW)
Personal, Mobility, Interoperable, device & cost/bit optimized

Seamless user experience requires ubiquitous and access agnostic subscriber management with tight radio integration. Mobile centric logic is the way forward.
MBB vs Integrated WiFi

A WiFi Access Network like MBB RAN requires Core Network to
- Authenticate the subscriber
- Establish and Manage the Session
- Policy decision and enforcement
- Charging & LI
- Wholesale, Roaming agreements
- Integrate with existing Packet Core and User Data Management
Balance User Experience with Network’s Challenges

› End user convenience with automatic and secure login
  – Moving beyond portal based login

› Broadest possible end user offering
  – Support for both SIM based and non SIM based WiFi devices

› Network knowledge providing optimized resource usage and always best connected service

› Plug and play into backend systems using GTP from Radio to Mobile Core
HotSpot2.0 (HS2.0)

- Industry moving to standardize some aspects of Carrier-grade WiFi
  - Standardized mechanism for connection establishment
  - Secure seamless roaming
- Focus is ease of use – i.e. more like cellular
- Ericsson is at the forefront of HS2.0 and strongly supports it
  - Software upgrade to BelAir OS
  - Operator trials through WBA
- Expect to see smartphones supporting HS2.0 in 2H2012
HotSpot2.0 and ANDSF Integration

› Access Network Discovery and Selection Function (ANDSF)
  – To assist UE to discover WiFi – in addition to 3GPP and to provide the UE with rules policing the connection to these networks.
  – Policies sent to the UE for different types of functionality
  – Has not yet taken off

› Hotspot 2.0 Phase 2 starting up
  – Support for operator policy provisioning (incl. access selection)
  – Ongoing work in WiFi alliance (terminal support FFS)

› New Work Item proposal in 3GPP (now)
  – Goal to enhance ANDSF to take into account Hotspot 2.0 solutions
What does Hotspot2.0 provide?

› Phase 1 – for SIM and non-SIM devices
  – Automatic network reporting and discovery
  – Automatic network selection
  – Secure authentication and link encryption
  – Roaming across many operators
  – Certification program launched June 2012

› Phase 2 – for non-SIM devices
  – Immediate account provisioning of non-subscription (pay-per-use) users
    › Secure distribution of credentials for non-SIM devices
  – Delivery of policy to WiFi devices
    › Move control of selection from device to network
    › HS2.0 allows selection of which WiFi network
    › WiFi vs 3G selection to be aligned with ANDSF
  – Certification program launch 1Q2013
Terminal Authentication  EAP-SIM

› Leverages SIM card in mobile device
  – Configuration-free authentication

› Requires connection to associated HLR
  – Natural choice for FMC for a mobile operator
  – AAA can check realm in Identity to see if HLR is available
    › If not, can switch to EAP-TTLS
## Device Compatibility

various EAP and non-EAP Authentication Modes

<table>
<thead>
<tr>
<th>Device</th>
<th>SIM</th>
<th>TLS/TTLS</th>
<th>LEAP/FAST</th>
<th>PEAP</th>
<th>WISPr App.D</th>
<th>Portal UAM</th>
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</thead>
<tbody>
<tr>
<td>iPhone</td>
<td>Y</td>
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<td>Android</td>
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</tr>
</tbody>
</table>
iPhone 5 Radio Access Interface

› **GSM model A1428**
  - UMTS/HSPA+/DC-HSDPA (850, 900, 1900, 2100 MHz)
  - GSM/EDGE (850, 900, 1800, 1900 MHz)
  - LTE (Bands 4 [2100 MHz] and 17 [700 MHz])

› **CDMA model A1429**
  - CDMA EV-DO Rev. A and Rev. B (800, 1900, 2100 MHz)
  - UMTS/HSPA+/DC-HSDPA (850, 900, 1900, 2100 MHz)
  - GSM/EDGE (850, 900, 1800, 1900 MHz)
  - LTE (Bands 1 [2100 MHz], 3 [1800 MHz], 5 [850 MHz], 13 [700 MHz], 25 [1900 MHz])

› **GSM model A1429**
  - UMTS/HSPA+/DC-HSDPA (850, 900, 1900, 2100 MHz)
  - GSM/EDGE (850, 900, 1800, 1900 MHz)
  - LTE (Bands 1 [2100 MHz], 3 [1800 MHz], 5 [850 MHz])

› 802.11a/b/g/n WiFi (802.11n 2.4GHz and 5GHz)

› Bluetooth 4.0 wireless technology
Summary

 › WiFi positioning
   - WiFi as part of heterogeneous network
   - Optimum usage of cellular network and WiFi network pursued

 › WiFi product portfolio
   - Products of Belair as the starting point
   - Various access points for Indoor, outdoor and stadium use
   - WiFi Controller, WiFi Manager and WiFi Analyzer
   - Track records for very large-scale WiFi networks

 › Ericsson Network Integrated WiFi (ENIW)
   - Integration of cellular network and WiFi
   - Seamless access between cellular radio and WiFi access

 › Activities in Japan
   - Business development understanding specifics of Japan, e.g. congestion at stations
   - Possibility of field trial in near future