

Radio Resource Measurement

Radio Resource Measurement Tutorial



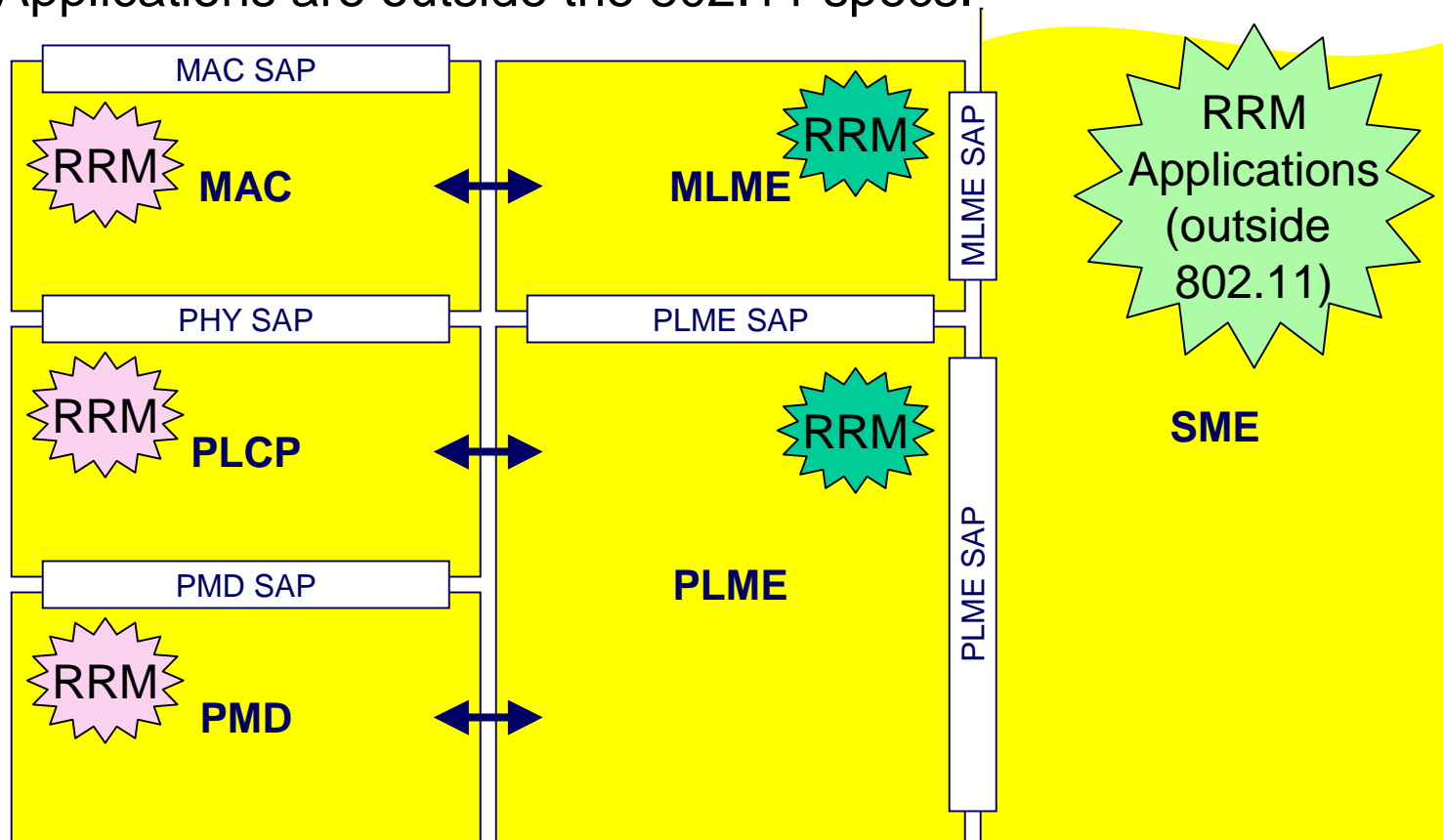
Radio Resource Measurement

Agenda

- Why Radio Resource Measurement now?
- 802.11 Existing Measurement Approach
- Proposed Approach
- Requirements
- Issues
- Futures
- Conclusions

Radio Resource Measurement RRM Extension Options

- RRM blue stars show the likely location of RRM extensions, though RRM pink stars are (remotely) possible.
- RRM Applications are outside the 802.11 specs.



MIBs – current

- **802.11**
 - Basic measurements & configuration for STA
 - Widely implemented in APs
 - Very simple monitoring of global AP statistics
- **802.1x**
 - Detailed auth state for individual 1x ports
 - Also some per port statistics
 - Not widely implemented in access points today
- **Bridge MIB**
 - Possible to get some info on which STAs are associated with an AP
 - Implemented in some APs
 - Not 802.11 specific, little MAC, and no PHY statistics

Work from existing TGs

- 802.11d
 - dot11CountryString
- TGe
 - dot11AssociatedStationCount
 - dot11ChannelUtilization
 - dot11FrameLossRate
- TGi
 - Write only key access, & IV status
- TGh
 - Configuration, but no status, monitoring or statistics!!!

Purpose of additions

- Enable better diagnostics of problems
 - Using info that is easy and cheap to gather
- Enable better frequency planning, optimize network performance
 - Enable automatic frequency planning
- Enable new services
 - Location based services

Radio Resource Measurement

Diagnostics

- Interference from non 802.11 sources
- Interference from other 802.11 networks
- Interference from other APs within same ESS

Radio Resource Measurement

Add Station Table to MIB

- Station table is list of wireless STAs an AP knows about
- Also applicable to IBSS
- Currently implemented by many APs, as proprietary MIB/telnet/web interface

Link Statistics

- **dot11MACStatistics**
- **Counts of**
 - MSDUs/MPDUs received/transmitted
 - Channel utilization in rx & tx direction
 - Measured as total μ s
- **Data rate & modulation of last rx and tx**
- **RSSI, signal quality**
- **Link margin as seen by other station**
 - Available for 11h stations
 - Either use recent measurement report, or request report for each SNMP request

Radio Resource Measurement **Add MAC Statistics to MIB**

- Channel utilization from TGe
- Total associated stations
- Total authenticated stations
- Optional events to notify mgmt station of authentication and association events
 - Current MIB sends TRAPS on assoc/auth failures

Events to Report

- Allow all events to be configurable as
 - Not reported
 - Reported as TRAP (unreliable)
 - Reported as INFORM (reliable)
- Default configuration should give same events as current 802.11 MIB
- Report all pre RSN auth/deauth events
- Report all association/deassociation events

Radio Resource Measurement Requirements Categories

- **Data, Voice, Video**
 - Data – QoS, wireless net (a, b, g, h)
 - Voice – RSSI, S/N, Delay, Jitter, Encryption, device processor, wireless net (a, b, g, h)
 - Video – RSSI, S/N, Encryption, device processor, wireless net (a, b, g, h)
- **Diagnostics (non-802.11, 802.11, other APs)**
- **Access Point Table**
- **Station Table (BSS and IBSS)**
- **Link stats (counts, data rates, RSSI, link margin)**
- **MAC Statistics (channel utilization, total stations, events)**
- **Events (auth, deauth, associate, deassociate, current MIB)**
- **Coexistence Measurements**
- **Retries**
- **Clear Channel Assessment**

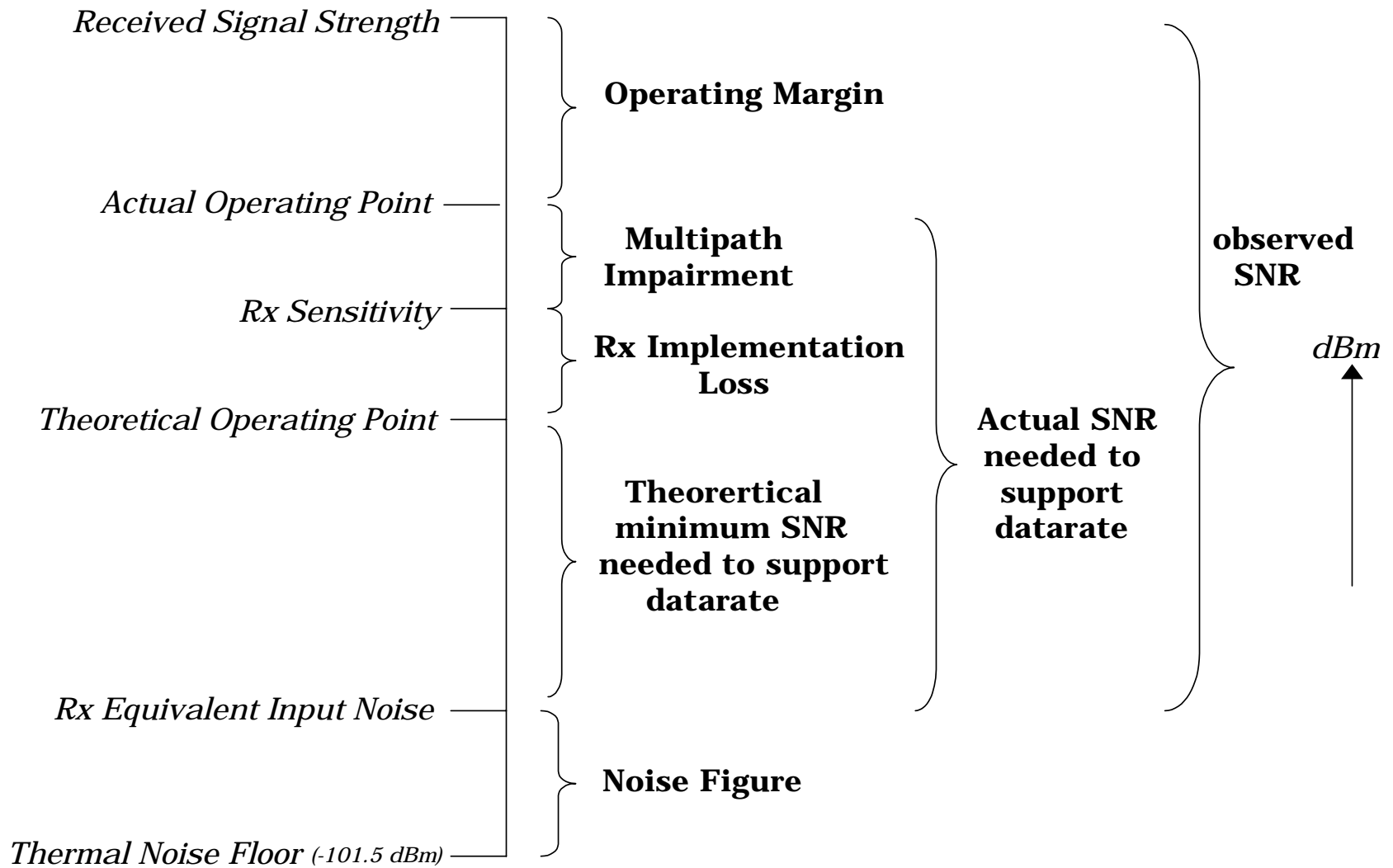
Radio Resource Measurement

Paper Topics

- MIBs
- Signal Strength
- Standardizing RSSI
- Real Time Parameters
- Real Time Issues
- Retries
- Measuring Transmission Speeds
- Measuring Throughput in WLANs
- VOIP Radio Resource Issues
- Video Radio Resource Issues
- Additional Information needed in the MIBs (802.1x, 802.11, 802.1p)
- Diagnostics Needed for Effective Mgt of WLANs

Relationship of RSSI, Operating Point, Sensitivity, SNR

Radio Resource Measurement



Radio Resource Measurement

What should not change at any station?

- Wireless MAC control frames and procedures**
- Wireless MAC data frames and procedures**
- Any hardware, including MAC and PHY**

The TGh model

- The 802.11 standard place MIBs in the MLME and PLME and specifies access from SME via the MLME SAP and PLME SAP using generic GET/SET primitives [see Figure 63 of ISO/IEC 8802-11:1999(E)]
- TGh handles measurement and control using MLME primitives.

Radio Resource Measurement *TGh layer management model*

- Extract from 802.11h-D2.1.32, which addresses some measurement extensions for DFS and TPC.

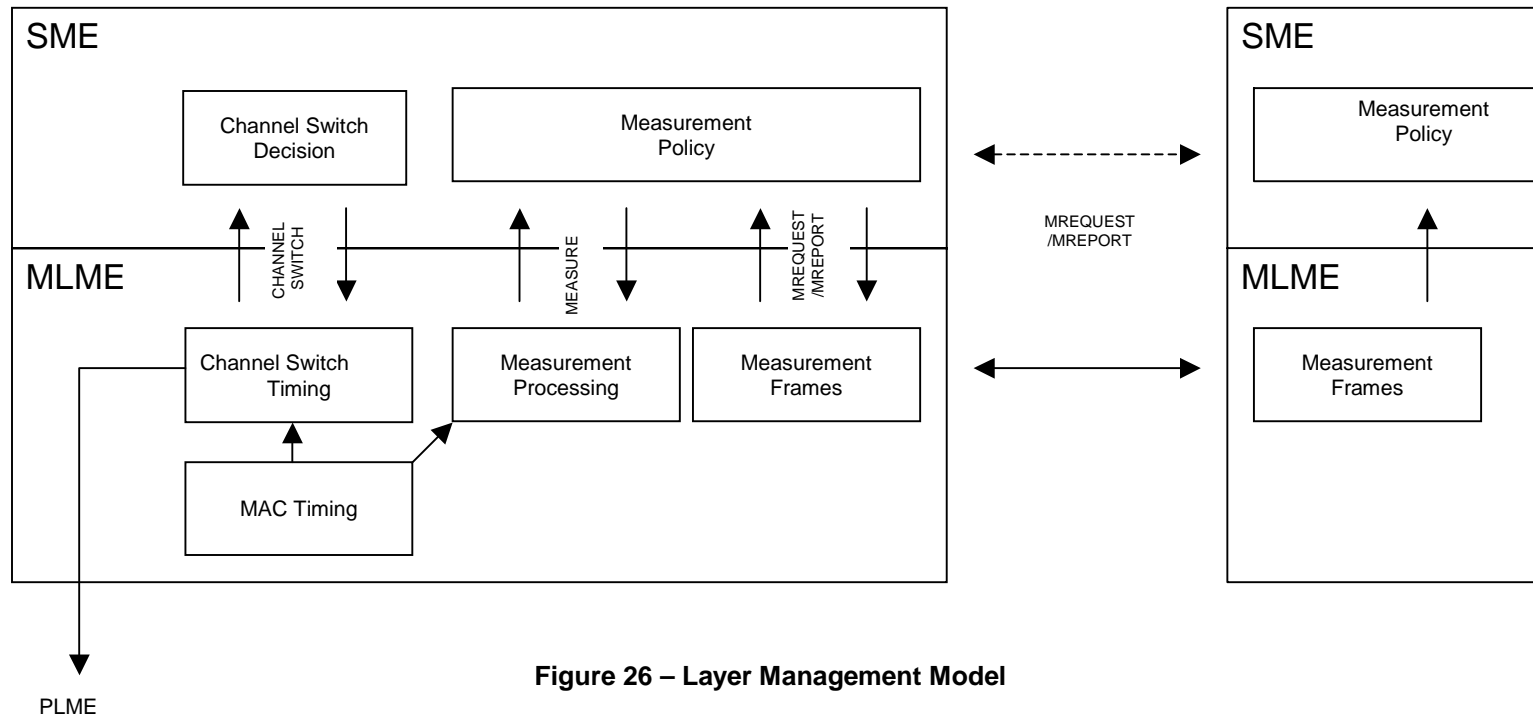
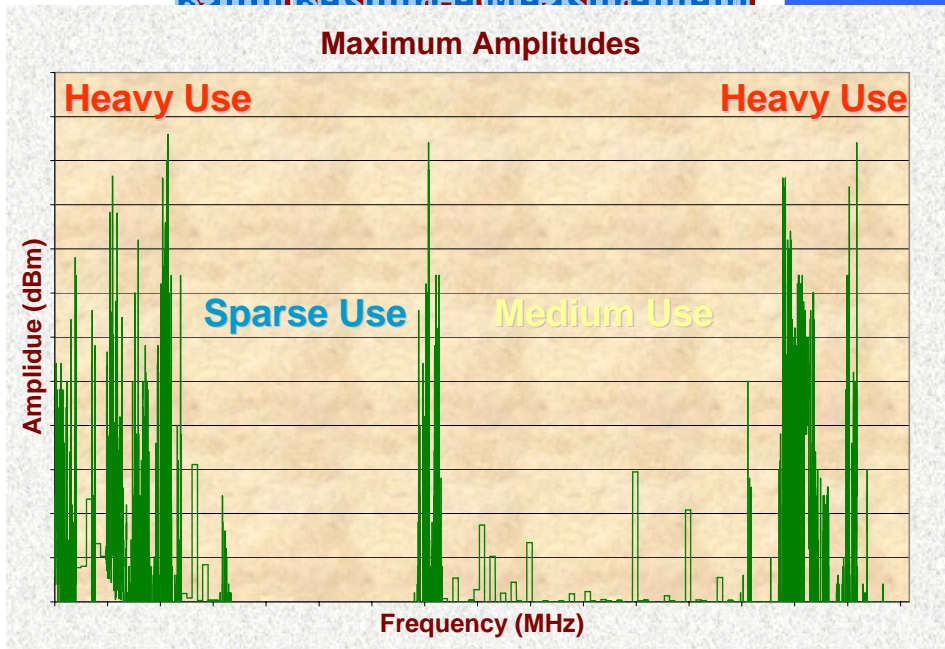


Figure 26 – Layer Management Model

Radio Resource Measurement *Future Allocation & Utilization*

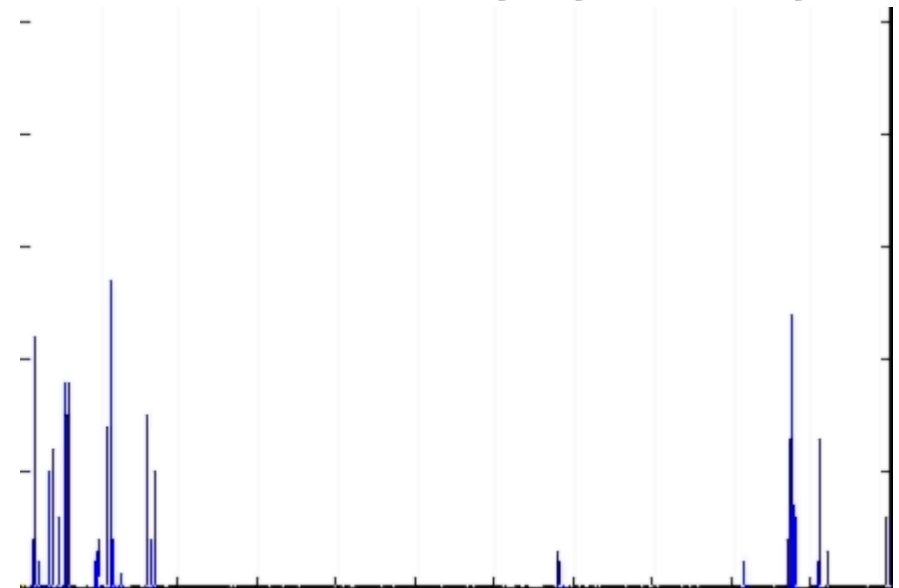


Fixed Spectrum Assignments Lead to Inefficient Spectrum Utilization

- Opportunities Exist in Time, Frequency, and Geography

RF Spectrum Allocated by Policy

- Allocations, Assignments, and Incumbents Vary by Country



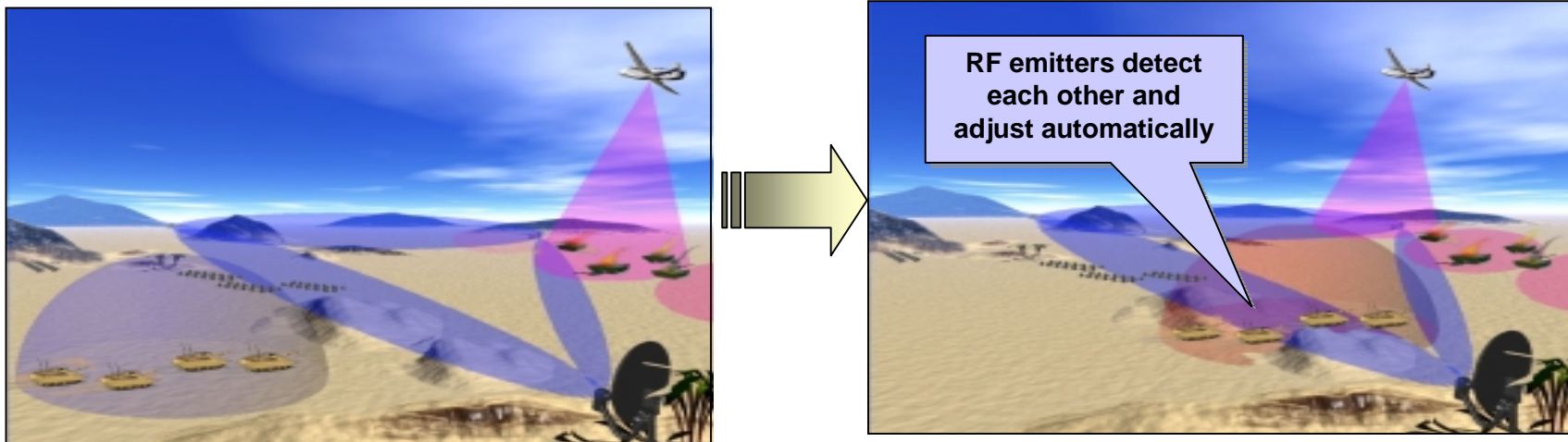
Observations Show Bands of Local Heavy and Sparse Activity

- Temporal Usage Characteristics Vary by Band & Service
- Potential for Usage Dependent on Incumbent Service & Equipment

•Static Spectrum Management is Limited in Its Ability to Improve Spectrum Utilization Efficiencies

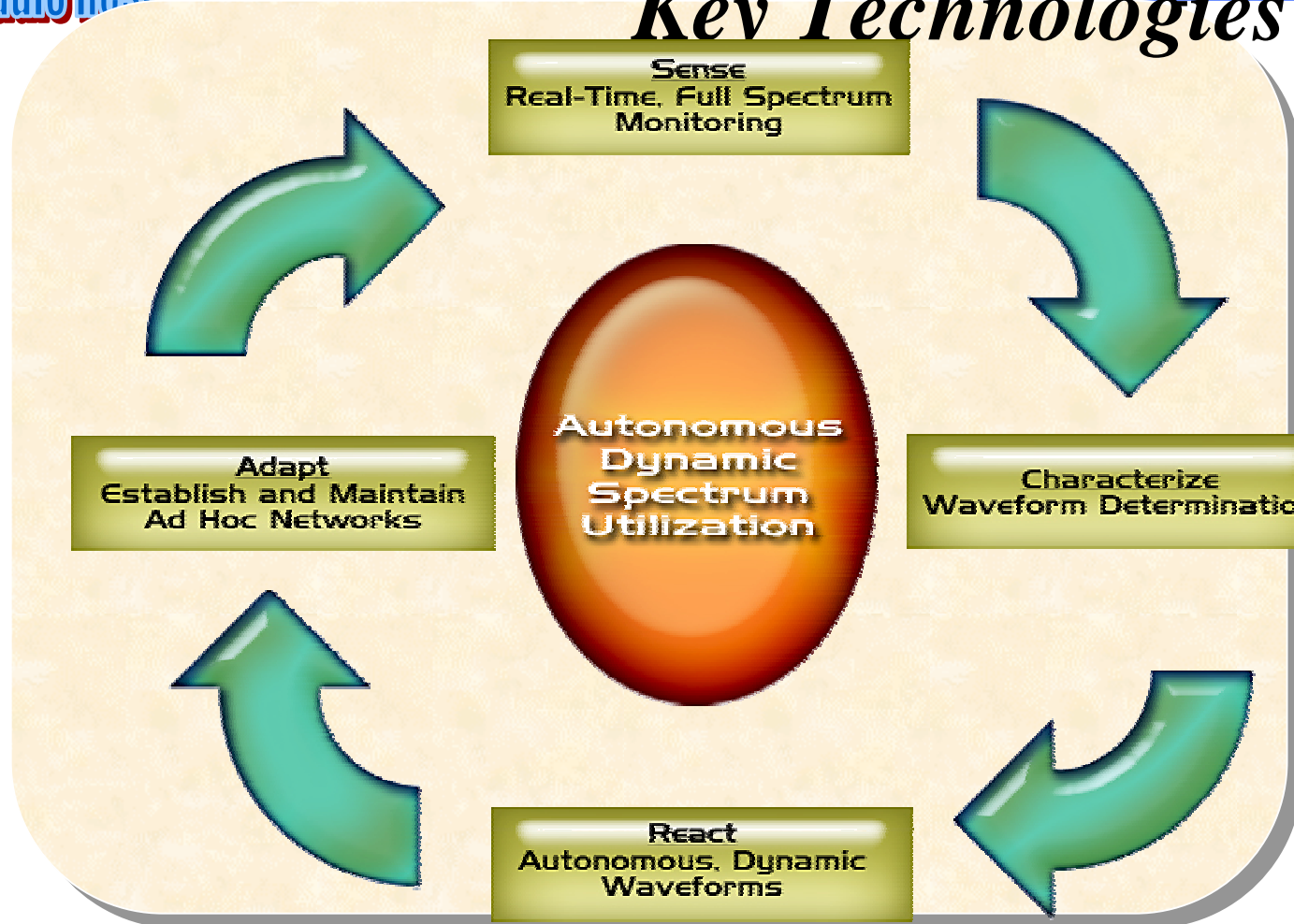
Radio Resource Measurement *What is the XG Program?*

- Develop both the Enabling Technologies and System Concepts to *Dynamically Utilize Spectrum*
 - Improve Efficiency of Current, Static Assignments for Voice and Data (Threshold: Factor of 10, Objective: Factor of 20)
 - Provide Capability to Share Spectrum with disparate systems



XG Systems Will Opportunistically Utilize Unoccupied Spectrum in Time, Space, and Frequency

Key Technologies



•Develop Both the Enabling Technology and the System Concepts to Dynamically Use Spectrum

Conclusions

- **Measurements Necessary for Future Growth**
- **Fast Track for Radio Resource Measurement**
- **More Control May Be Adopted as a Next Step (another task group)**
- **Future Technologies Require More Measurement**
- **Automating Radio Environment Adaptation**