Enabling Technologies and Standards for Spectrum Forensics

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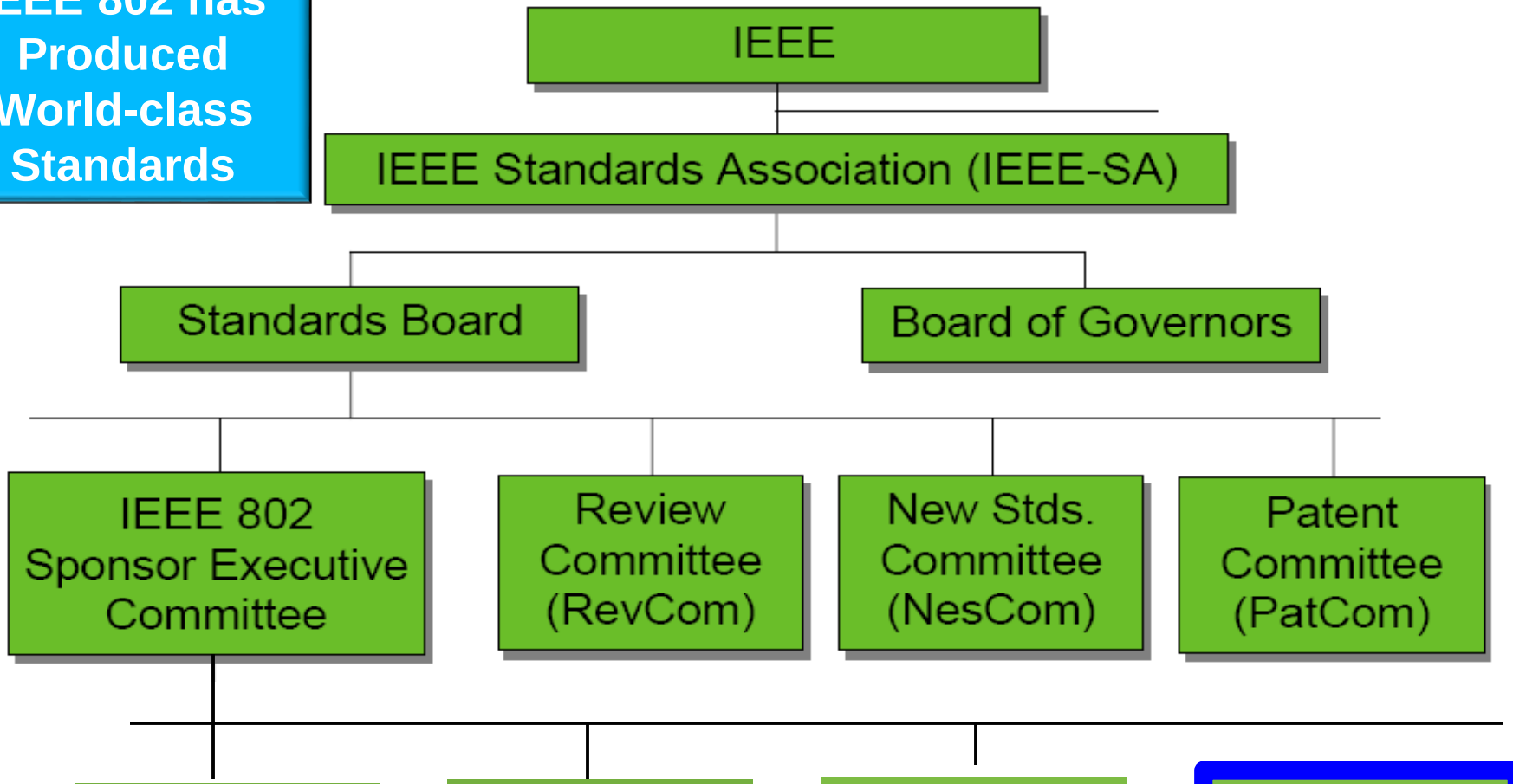
IEEE 802 Family of Standards – Successful Commercialization and Household Usage

IEEE 802 has Produced World-class Standards



IEEE 802

802.3 Ethernet

802.11 WLAN

802.15 WPAN

802.22 WRAN

IEEE 802.22 WG on Cognitive Radio Based Spectrum Sharing and Wireless Regional Area Networks

IEEE 802.22 WG is the recipient of the IEEE SA Emerging Technology Award – IEEE 802.22 (Wi-FAR™) Devices being Announced

IEEE 802.22 Standard – Wireless Regional Area Networks: Cognitive Radio based Access in TVWS

Saankhya Labs

NICT

IEEE 802.22 Standard for Operation in Bands that Allow Spectrum Sharing

- 802.22.1 – Std for Enhanced Interference Protection using beaconing
- 802.22.2 – Std for Recommended Practice for Deployment of 802.22 Systems
- 802.22a – Enhanced Management Information Base and Management Plane Procedures
- 802.22b Enhancement for Broadband Services and Monitoring Applications

802.22.1a – Advanced Beaconing

802.22.3 – Spectrum Characterization and Occupancy Sensing (SCOS)

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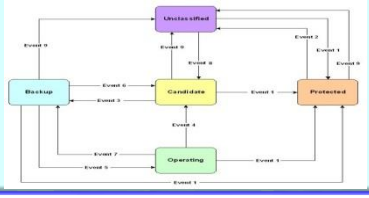
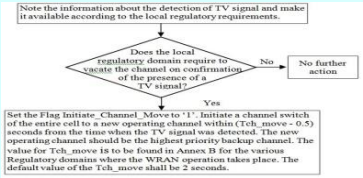
IEEE 802.22 – Wi-FAR™ – Cognitive Radio Capability Included Spectrum Sensing

Channel Set Management

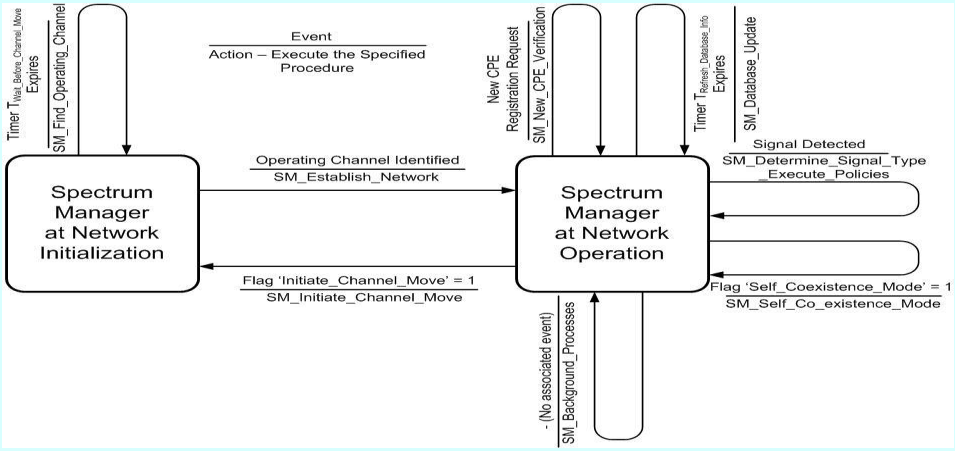


Subscriber Station Registration and Tracking

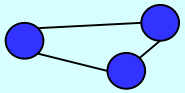
Policies



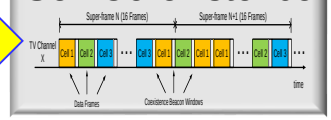
Spectrum Manager



Geo-location



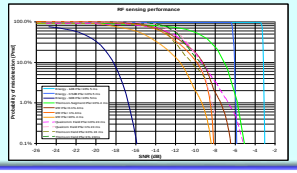
Self Co-existence



Database Service

IEEE 802.22 WG felt that there was a need for a more dedicated Standard for Spectrum Characterization

Spectrum Sensing



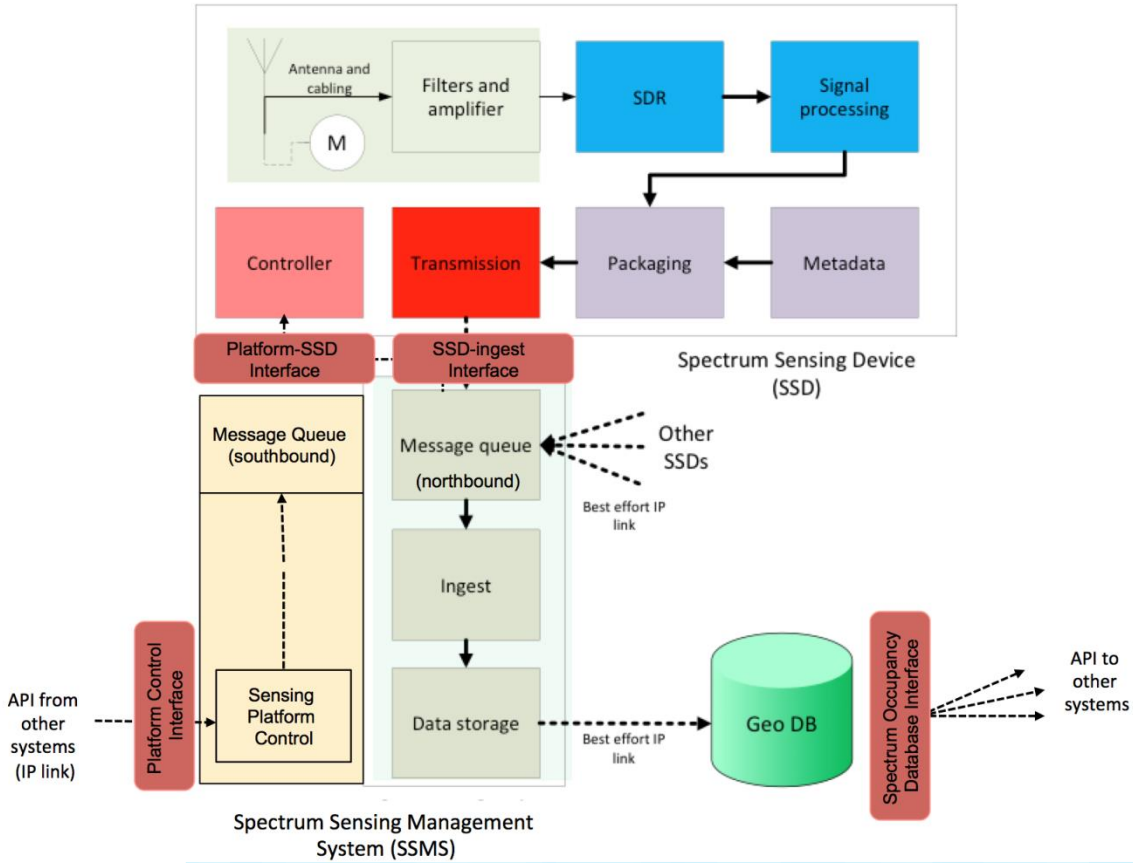
Maverick Expansion of Software Defined Radios and Sensing but there is a Standards Vacuum

Wavesink Plus
SondeMonitor
Cognitive Systems
Airprobe
dl-fldigi
Panorama
WxtoIMG
SoftFM
Microsoft
Modesdeco
acars_ng
PDW
RTL_433
BAE Systems
DStar
SeeDeR
ec3k
Orbitron
HDSDR
GR-AIS
Studio1
Acarsd
Linrad
SDR-J
NRF905 Decoder
PowerSDR
cuSDR
AISMon
Redhawk
ADS-B Decoder and Radar
RTL-SDR
GR-Phosphor
OpenCPN
Nutaq
SDR-RADIO.COM V2
GQRX
DREAM
QtRadio
Virtuel Radar Server
GNU Radio
NWRA
LibRadio
rtlamr
LTE-Scanner
GR-Elster
DAB_Player
Trunk88
WebRadio
Unitrunker
GlobeS
ViewRF
Sdrangelove
AmeriSys
Multimode
SDR_Lab
ShipPlotter
PlanePlotter
FunCube
SRD#
SDRWeather
GNSS
ShinySDR
Acarsdec
Radio Receiver for Chrome
RDS_Spy
ADSB
coca1090
adsbSCOPE
GR-RDS
SDR Touch
NRF24-BTLE Decode
gr-air-modes
Ettus
TVSharp
Sodira

IEEE 802

Over the last few years more than twenty thousand research papers have been written on spectrum sensing.

IEEE 802.22.3 – Spectrum Characterization and Occupancy Sensing (SCOS) Architecture



Architecture includes

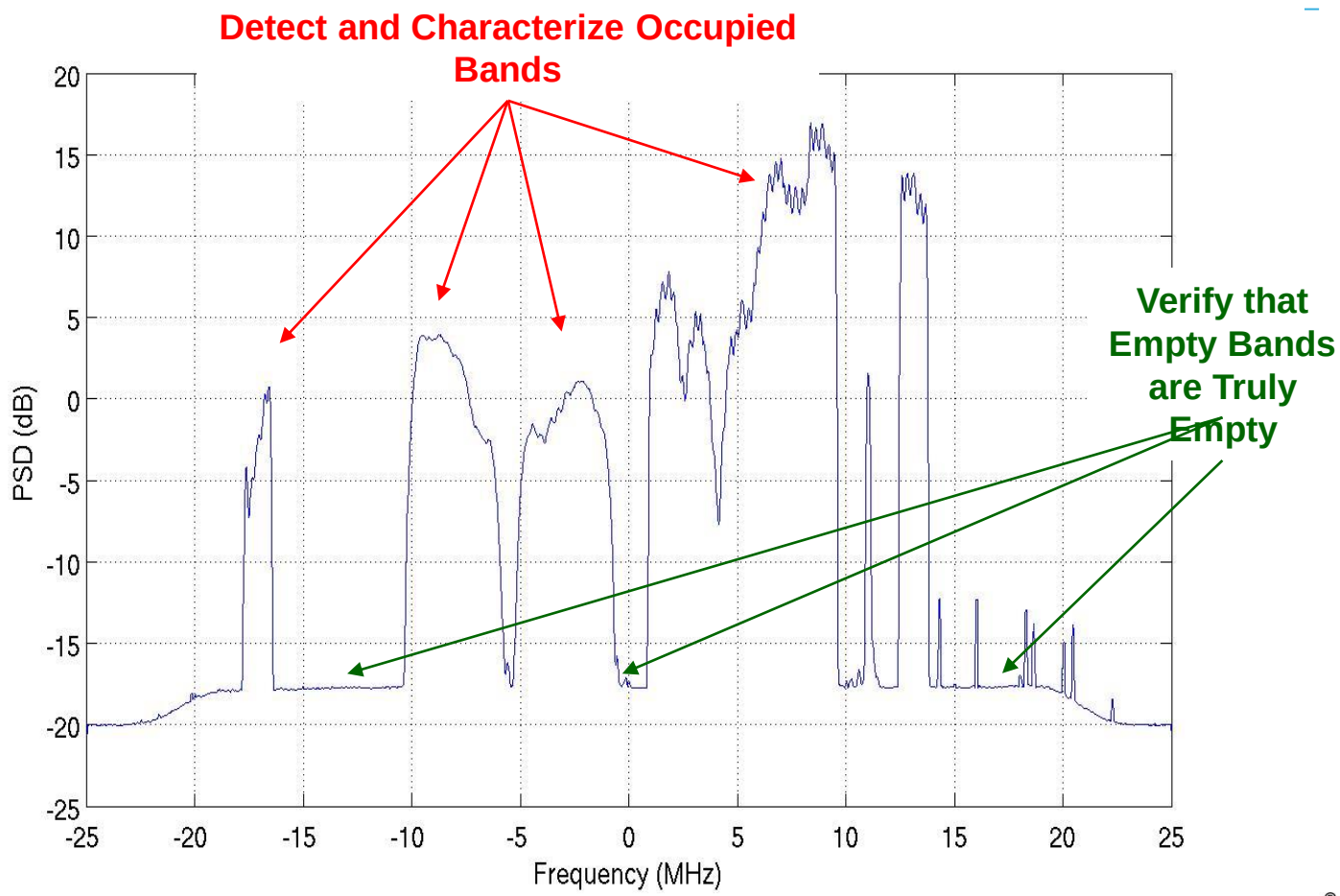
- Sensor – Three types
  - Energy efficient
  - Small form factor
  - Advanced
- Algorithms at the Sensor
- Protocol between a Backend Spectrum Sensing Manager (SSM) and the Sensor
- Database

There are other similar IEEE Standardization Activities On going – IEEE P1900.6. Collaboration Under Way

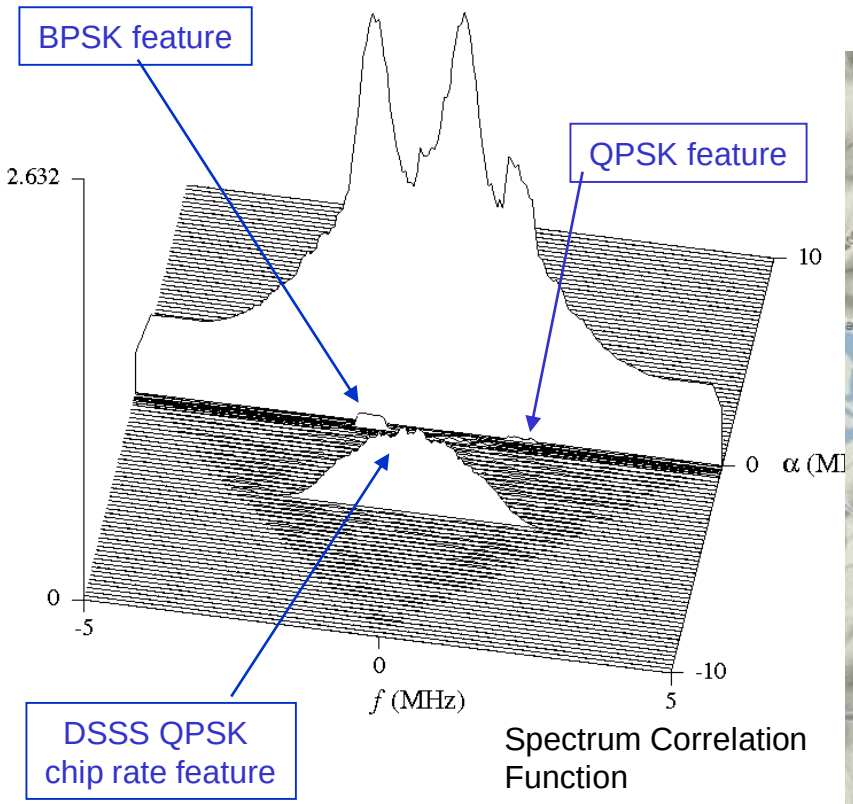
802.22.3 SCOS Challenges: Primary and Secondary User Signal Detection; White-Space Detection

Challenges

- Time-variant noise floor
- Colored noise floor
- Weak signals due to propagation effects
- Interference
- Multiple Sensing Devices with wide-range of capabilities

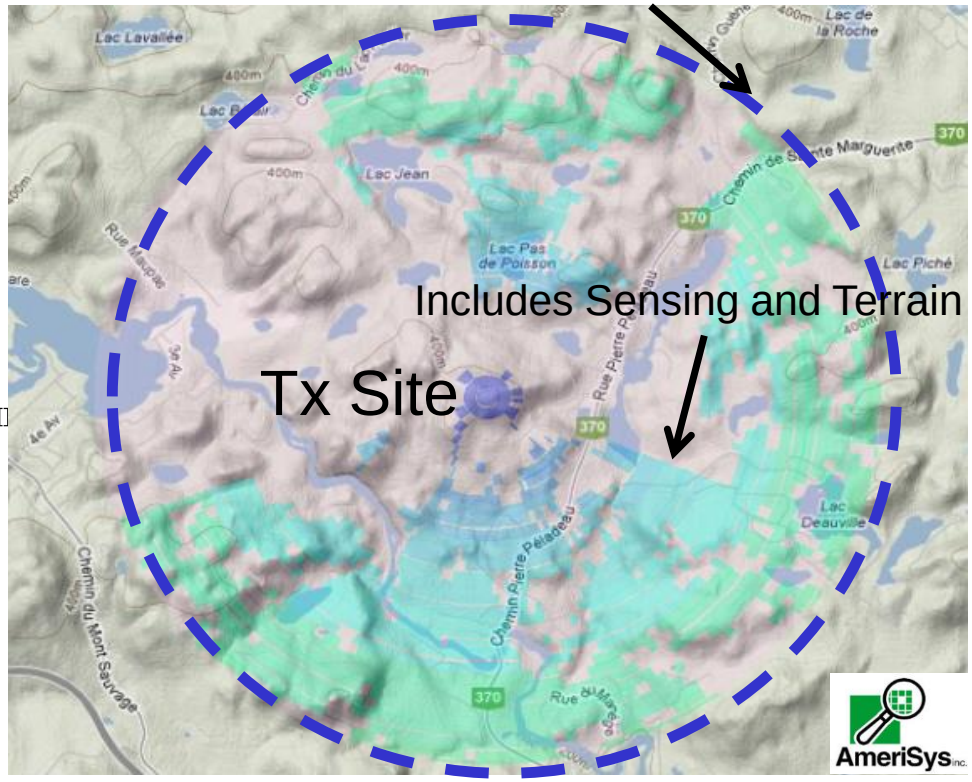


SCOS Anticipated Enabling Technologies



Spectrum Correlation Function

Exclusion Zones with No Sensing or Terrain Information



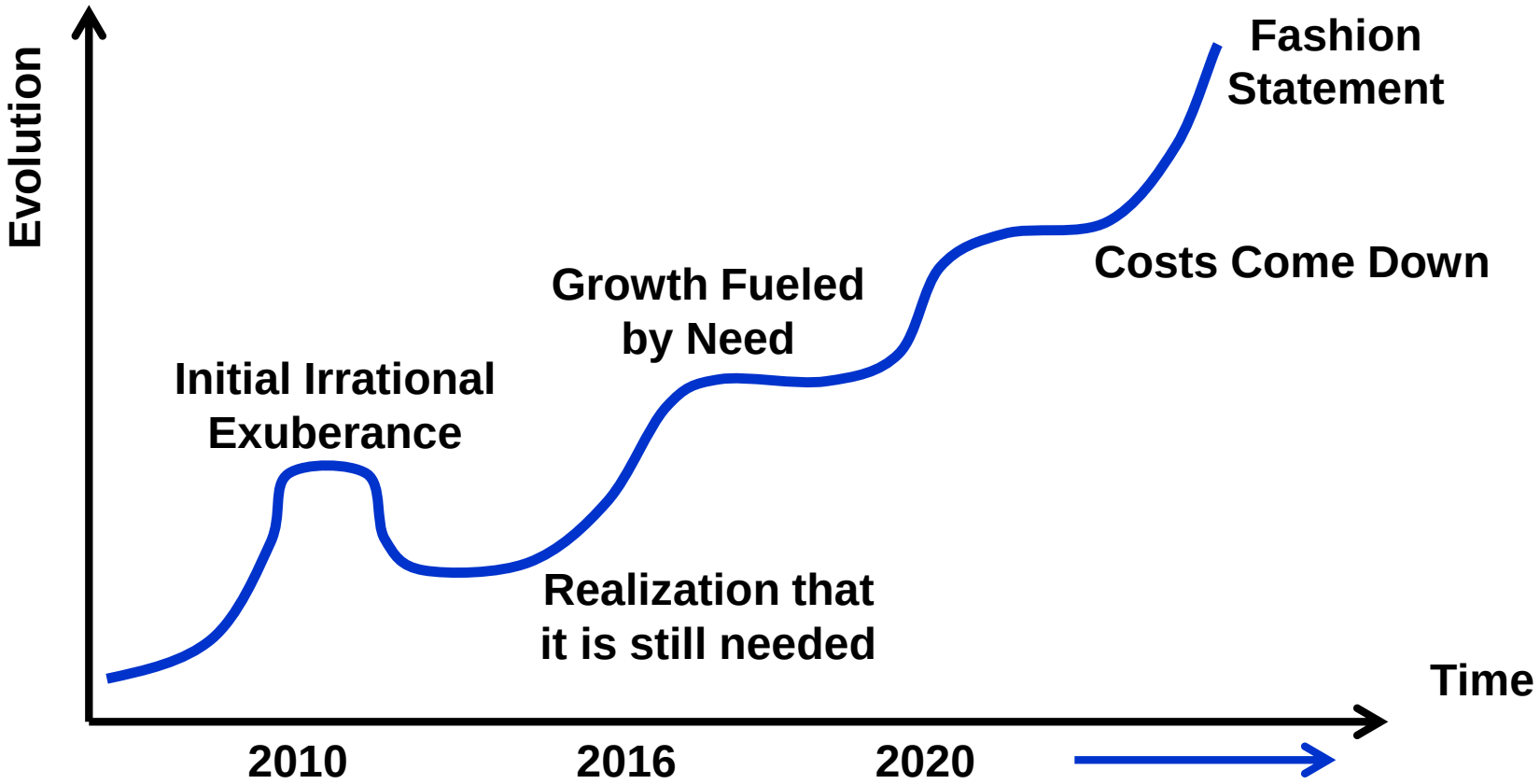
Sophisticated Sensing Algorithms (e. g. Cyclostationary)

Coverage based on SCOS and Terrain Information

802.22.3 SCOS Applications

- Quantification of the available spectrum through spectrum observatories
- On-demand spectrum survey and report
- Collaborative spectrum measurement and calibration
- Labeling/ classifying of systems utilizing the spectrum
- Spectrum planning, Spectrum mapping
- Spectrum Forensics
- Coverage analysis for wireless deployment
- Terrain and topology - shadowing and fading analysis
- Complement the database access for spectrum sharing by adding in-situ awareness and faster decision making.
- Space-Time-Frequency spectrum hole identification and prediction where non-time-sensitive tasks can be performed at certain times and at certain locations, when the spectrum use is sparse or non-existent
- Identification and geo-location of interference sources.

Spectrum Characterization Evolution



References

- IEEE 802.22.3 Spectrum Characterization and Occupancy Sensing (SCOS) Tutorial – Link
- IEEE 802.22.3 SCOS Project Authorization Request – Link
- IEEE 802.22.3 SCOS Criteria for Standards Development – Link
- IEEE 802.22.3 SCOS Proposal Selection Criteria – Link
- IEEE 802.22.3 SCOS – Preliminary Draft - Link