

Big RF for Spectrum Sharing Applications

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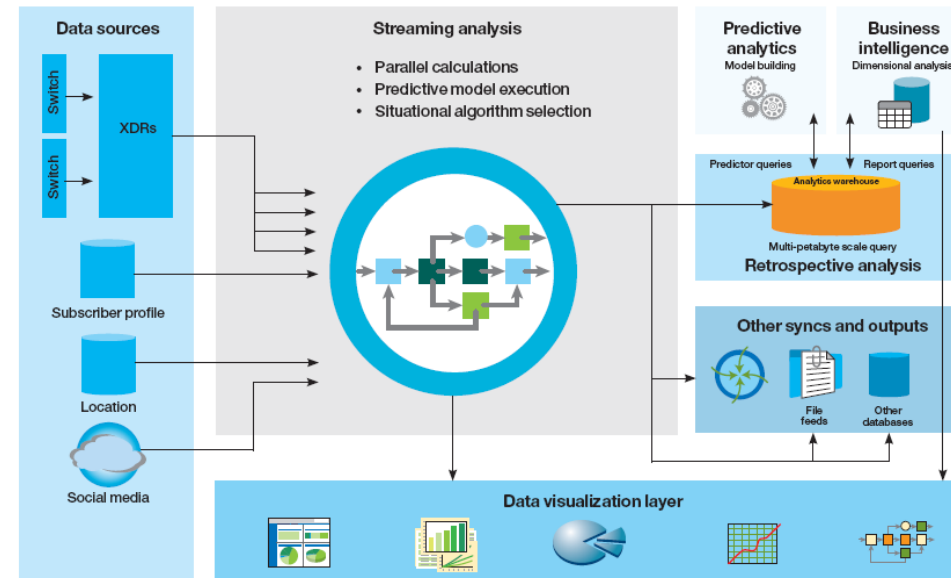
March 24, 2015
Wincomm 2015
San Diego, CA

Messages

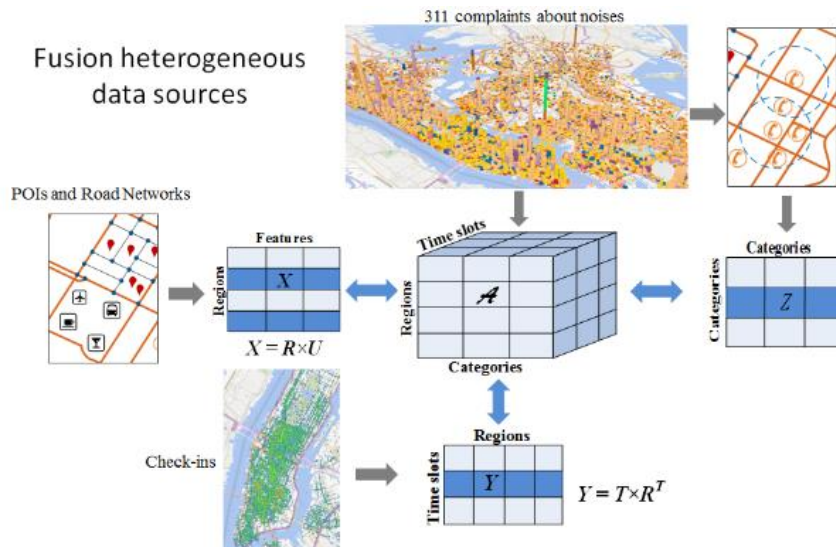
- Big Data is Increasingly Important for Wireless Network Management
- Latency is a limiting factor for many potential applications
 - Spectrum sharing and enabling context aware cognitive radios
- Architectural choices and existing tools could help address latency issues

Big Data provides analytic insights from complex data

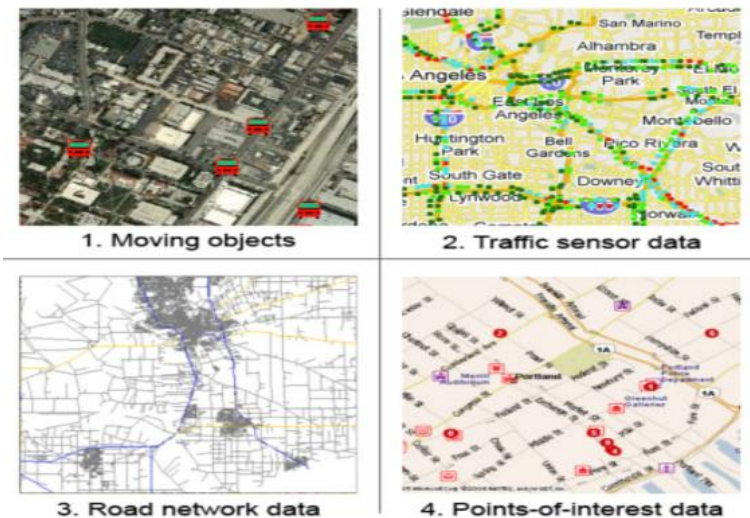
- **Volume** - the scale of stored data elements is too large for traditional processing to handle
- **Velocity** - new (streaming) data is arriving at a rate that on its own would be problematic
- **Variety** - insights are gained by combining data from multiple different sources with different syntaxes and semantics
- **Veracity** - decisions must be made under uncertainty due to physical limitations in data collection or flaws or variances in processes for maintaining data quality.



<http://www-01.ibm.com/software/data/bigdata/industry-telco.html>



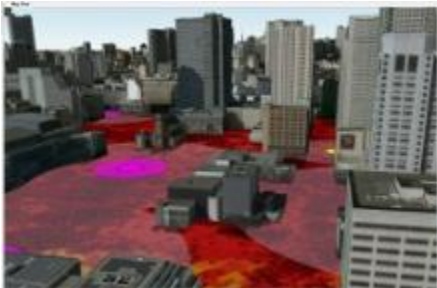
<http://research.microsoft.com/en-us/projects/citynoise/default.aspx>



<http://imsc.usc.edu/intelligent-transportation.html>

Keima

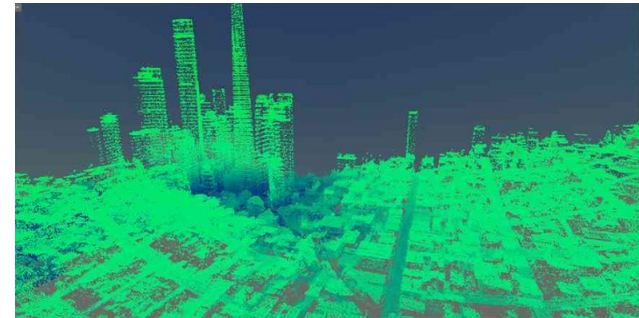
- Overture: Tool for small cell planning
 - <http://www.keima.com/>
 - Optimize location of small cells in context of traffic demand, RF propagation, location of macro-cells
- Demand estimation uses geo-tagged social media
 - Facebook, Twitter, Flickr
 - Also census tract data
- Highly detailed propagation models
 - < 1m accuracy
 - Trees, 3D rendering of buildings



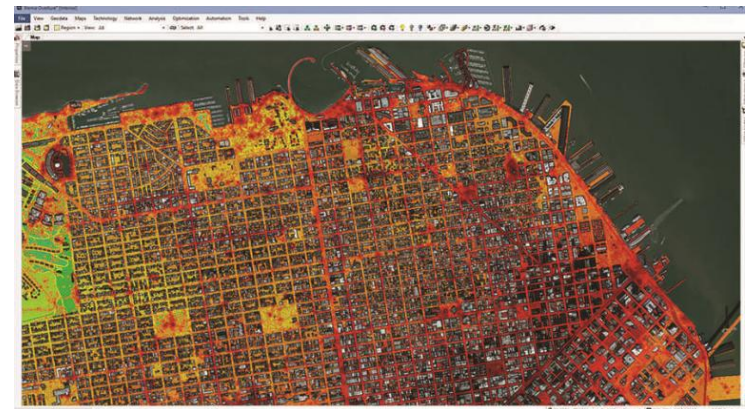
London Tweeting



Map Demand Location + Elevation



San Francisco Traffic Demand



Above: <http://www.keima.com/>

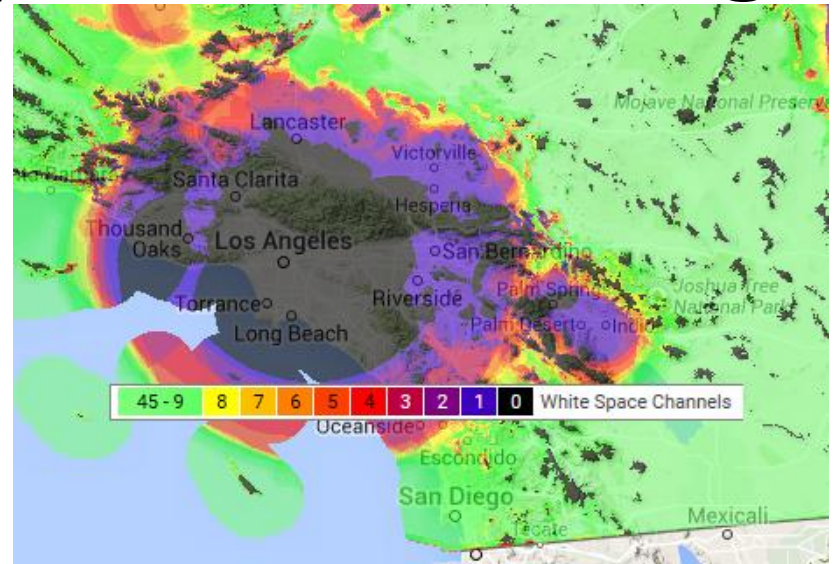
Left: <http://www.slideshare.net/fullscreen/zahidtg/keima-small-cell-planning/16>

Other Wireless Applications

- T-Mobile –
 - <http://www.lightreading.com/analytics/big-data/big-data-saves-t-mobile-big-bucks/d/d-id/709611>
 - 15 billion rows / 30 racks of physical gear, an open-source software framework for Big Data storage and analytics, and the RainStor Archive App, T-Mobile will be
 - Applications
 - Area of LTE coverage in which an abnormally high number of dual-mode phones were stuck on 3G.
 - where the popular iPhone 5 handsets were underperforming Androids on its network based on customer data, and then conducted more intensive testing to determine the cause of the problem so it could be fixed. That process can help keep iPhone 5 fans from jumping ship.
 - Tools: Hadoop 2.0 , IBM Netezza ->Rainstor
- K&M Wireless <http://www.kmswireless.com/>
 - Twitter data to estimate demand
 - Altyerx + IBM Streams for real time wireless analytics
 - Augment with drive testing of SINR

Database Driven Spectrum Sharing

- TVWS
 - Database driven
 - Daily updates
 - One class of secondary users
 - Location only
- 3550 MHz
 - Small cells
 - Updates < 10 minutes
 - Data from sensors and
 - Interference management
 - Slowly changing incumbents
- Next Band
 - SGLS Band / SSPARC / >24 GHz



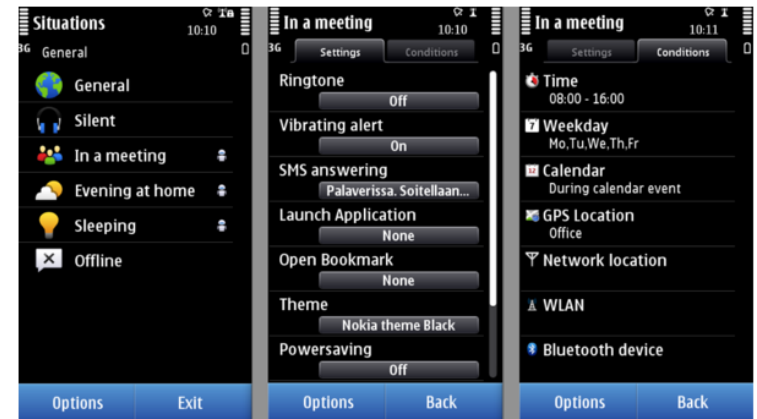
<https://www.google.com/get/spectrumdatabase/channel/>

- Exponentially increasing
 - Spectrum Access Message rate
 - Spectrum sample message rates
 - Number of subscribers
 - Propagation accuracy
 - Logic complexity

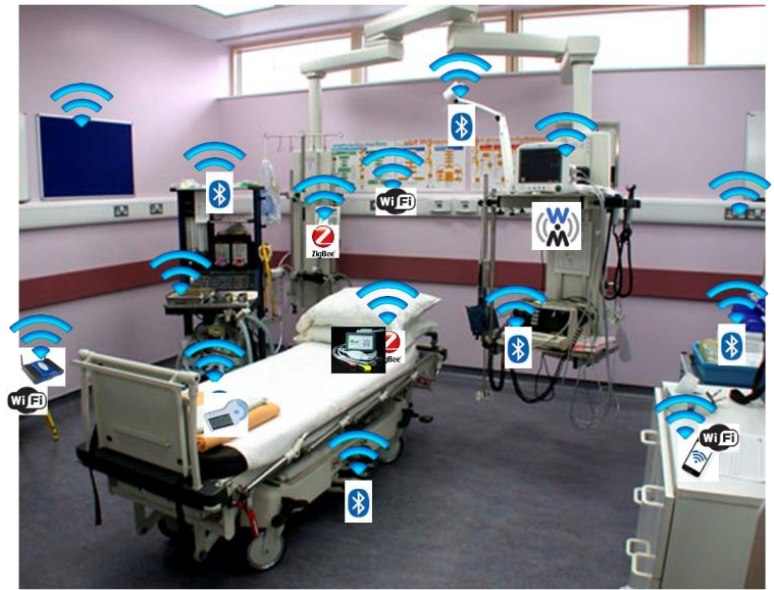
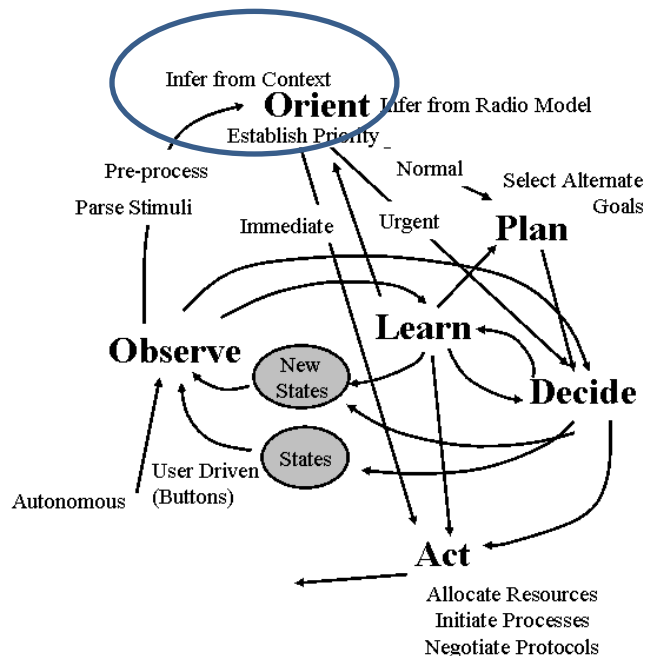
Context Aware Cognitive Radio

- Leverage information beyond normal wireless chipset metrics
- Adapt wireless parameters based on:
 - Social network considerations, mission objectives, shifting user objectives, disaster response policies

Situations from Nokia



http://www.readwriteweb.com/archives/nokias_new_situations_app_makes_phones_self-aware.php



Big RF: Big Data for Wireless Networks

- **RF Focus**

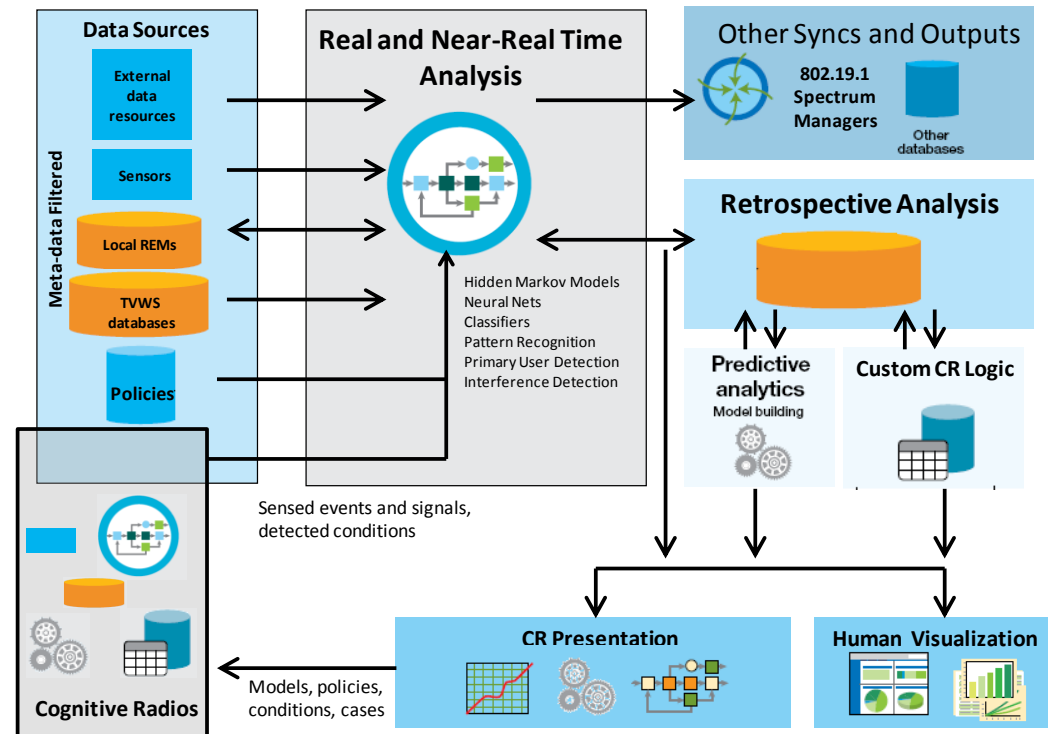
- Data sources and applications are more focused on RF
- Customized RF-specific logic
- Shorter-lived phenomena

- **Multiple analysis consumers**

- CR and human
- Implies CR “presentation” layer for Big RF results
- Could assist each other

- **Looping data flow** –

- CR is both consumer and source
- Feedback loops => stability concern
 - And security!



- **Self-similarity** –

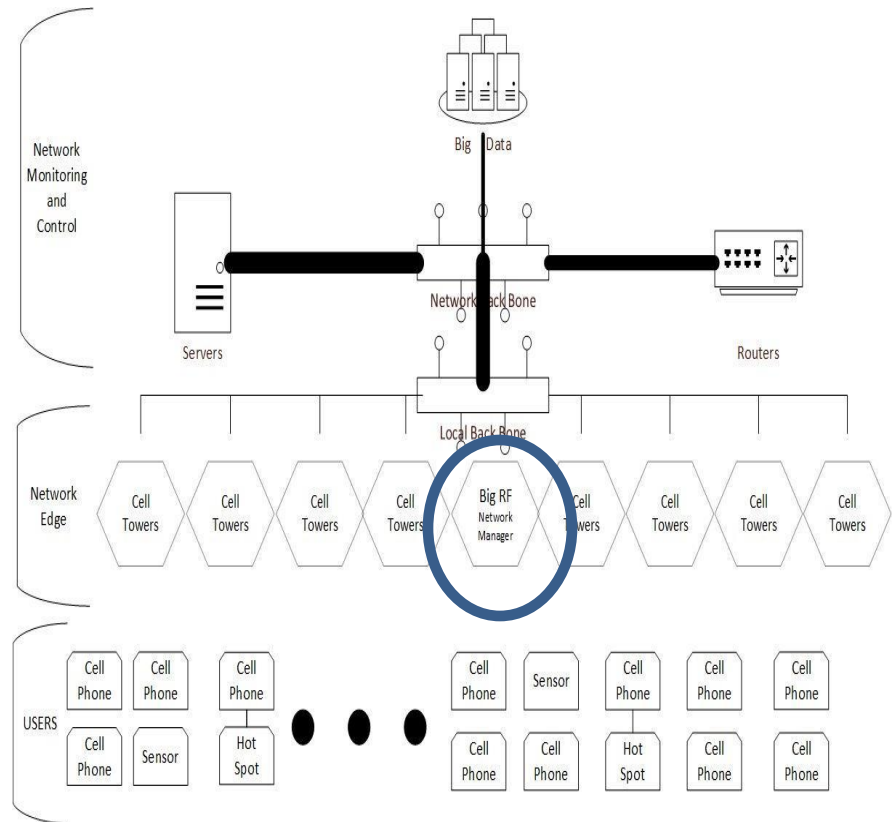
- Loosely, CR and Big RF are implementing the same processes
- Implies
 - means to scale up
 - Possibility of distributed implementation

Other Big RF Applications

- Intucell – Big Data for dynamic SON optimization
 - <http://www.datamation.com/news/cisco-to-buy-intucell-for-475-million.html>
- **NASA Electronic Radio Database Systems (NERDS)
 - Track and manage a large diverse set of spectrum using resources**
- DARPA RadioMap
 - Collect large number of RF measurements and collect into coherent picture of RF environment (locations and types of emitters)
 - EW Applications, Network management

Latency and Architectures Issues

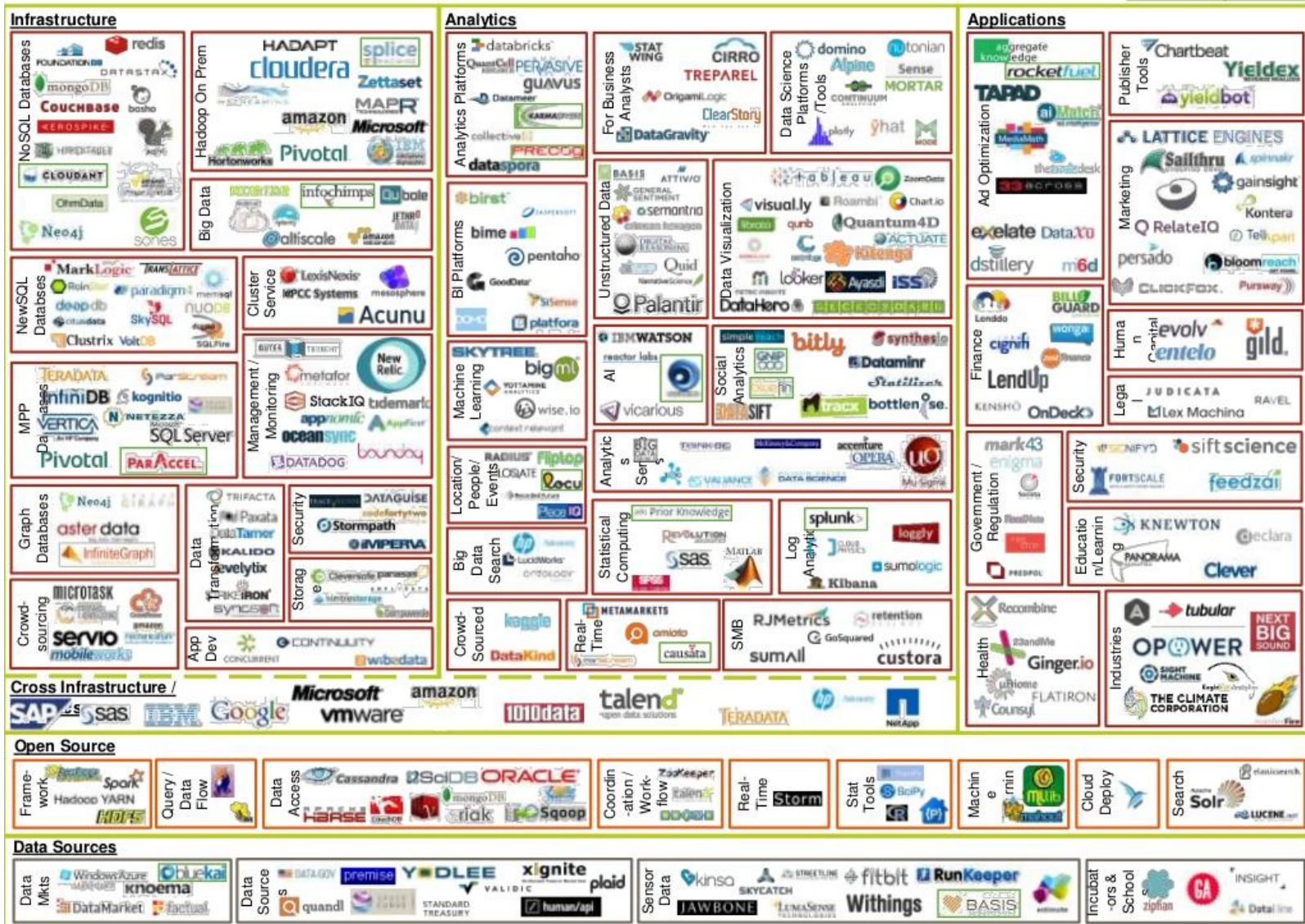
- Some applications require adaptations on the order of ms; others are not as time critical
- Distribute processing by type
 - Lower latency with narrower scope near edge
 - Higher latency and broader scope farther from edge
- General issue that “velocity” and streaming Big Data analyses are less mature



Big Data Tools

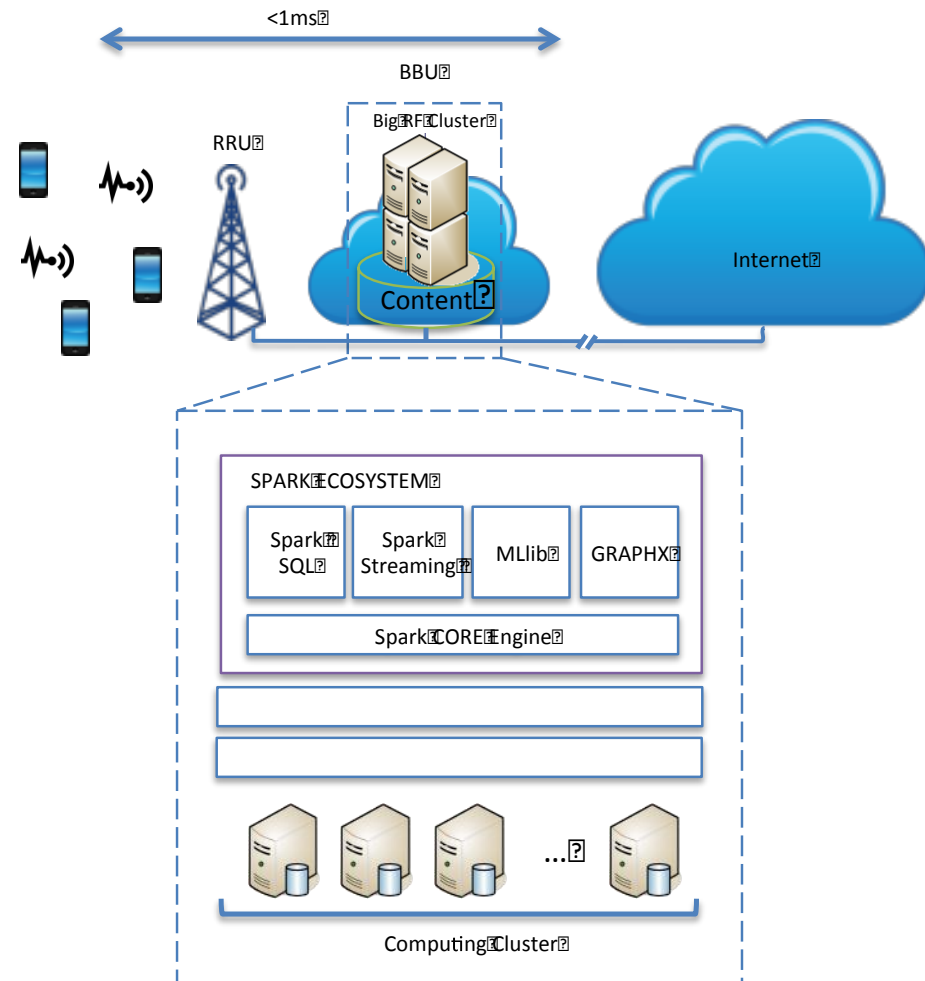
BIG DATA LANDSCAPE, VERSION 3.0

Exited: Acquisition or IPO



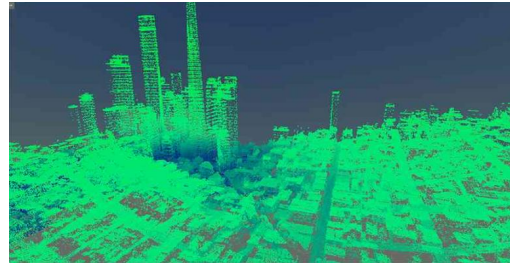
SPARK and Distributed Deployments

- Advantages to distributed implementation
- Offloading computation to the local BBU: Information processing on the cached data offloads communication and processing overhead that would otherwise be required if one main cloud computing system was used.
- Enhanced Security and Privacy: Localizing information reduces the attractiveness of any one target and reduces the number of potentially interceptable information transfers.
- Reduced Latency: For those applications that require only local communications, running algorithms locally on the data cached at the BBU reduces the end-to-end RTT delay.

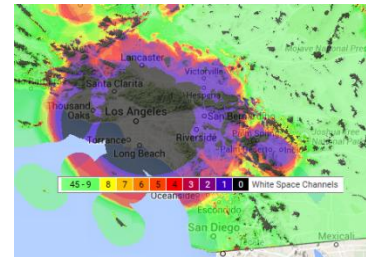


Takeaways

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TVWS -> 3550 -> SGLS, SSPARC?



Rupert Baines, "The Best That LTE Can Be: Why LTE Needs Femtocells"

