




SCUBA

Focus and Context
For Mesh Network Health Diagnosis

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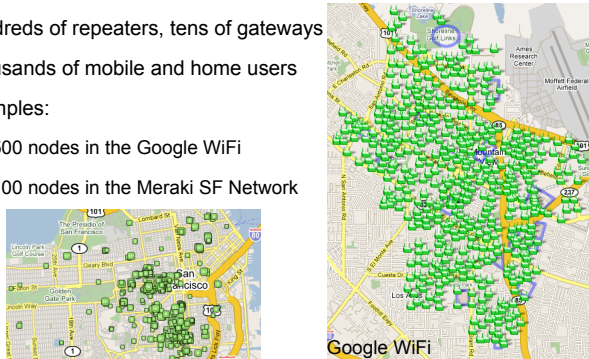

UC Santa Barbara

1

Scenario

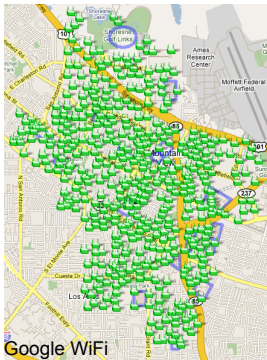

- Large-scale metro-mesh wireless networks
 - Hundreds of repeaters, tens of gateways
 - Thousands of mobile and home users
 - Examples:
 - ~500 nodes in the Google WiFi
 - ~100 nodes in the Meraki SF Network

2

Scenario

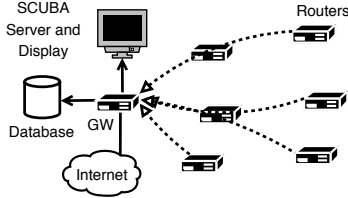

- Large-scale metro-mesh wireless networks
 - Hundreds of repeaters, tens of gateways
 - Thousands of mobile and home users
 - Examples:
 - ~500 nodes in the Google WiFi
 - ~100 nodes in the Meraki SF Network
- Diagnosing performance is hard
 - Multitude of metrics
 - Graphs and plots are tedious
 - Time-consuming and exhausting

3

SCUBA


- What is SCUBA?
 - Visualization framework to diagnose mesh network performance

4

SCUBA


- What is SCUBA?
 - Visualization framework to diagnose mesh network performance
- Design goals
 - Reduced clutter and occlusion
 - Intuitive visualization
 - Interactive interface
 - Selectable modalities
- Impact
 - Fast and efficient diagnosis
 - Better diagnostic framework design



5

Outline

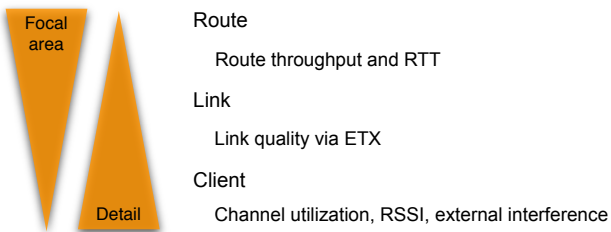
- Reduced clutter and occlusion
 - Focus and context approach via tiers of metrics
- Intuitive visualization
 - Choice of color schemes, sizes, shapes, and textures
- Interactive interface
 - Zooming and focussing
- Selectable modalities
 - Planar and hyperbolic views
- Implementation on the UCSB MeshNet
- Future work



6

Reducing clutter and occlusion

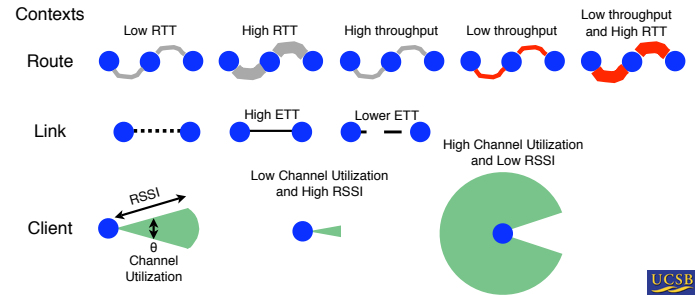
- Focus-and-context approach
 - Organize metrics into *tiers* or *contexts*
 - Top-most context = broad overview; bottom-most = most detail



7

Intuitive visualizations

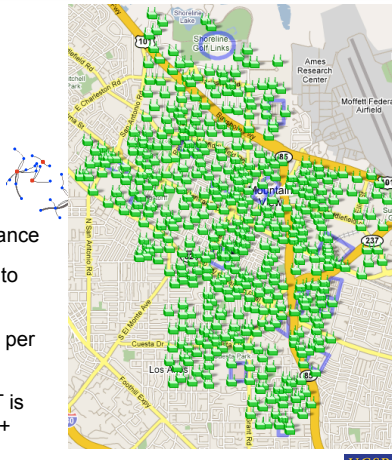
- Intuition
 - a keen or quick insight, ability to understand immediately
- SCUBA's choice of intuition: Highlight problems
 - Color schemes, shapes and sizes, and textures



8

Sample network

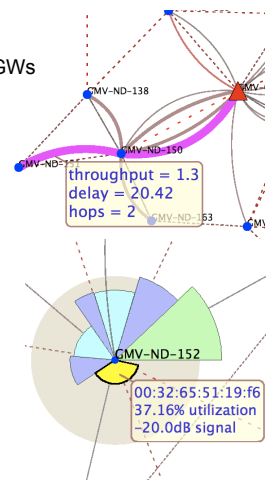
- Google WiFi
 - 425 routers, 66 gateways
 - ~2000 clients per day
- Tailored data
 - ETX is proportional to distance
 - Routes are shortest paths to closest gateways
 - Random number of clients per node
 - Route throughput and RTT is based on number of hops + some randomness



9

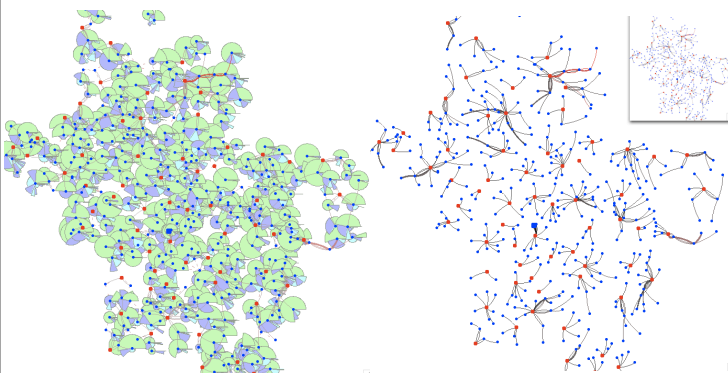
Visualization examples

- Route and link contexts
 - Routes are curved lines from routers to GWs
 - Links are straight lines between nodes
 - Metrics displayed on mouse-overs
- Client context
 - Circle sectors represent a client
 - Client metrics displayed on mouse-overs



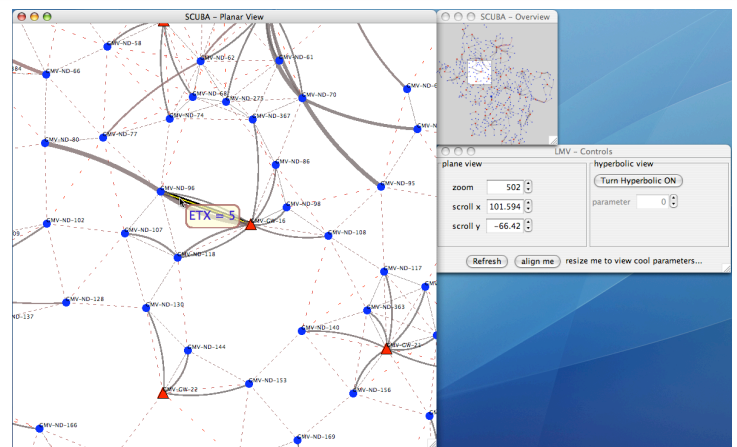
10

Motivation for focus-and-context



11

Interactive interfaces



12

Selectable modalities

- Provide different perspectives

- Colors, shapes, textures
- Spatial views

- Colors, shapes, textures

- Highlight problems vs.

Actual performance



- Spatial views

- Planar and Hyperbolic



13

Hyperbolic view*

- Idea

- Projection of a planar view on a hyperbolic surface

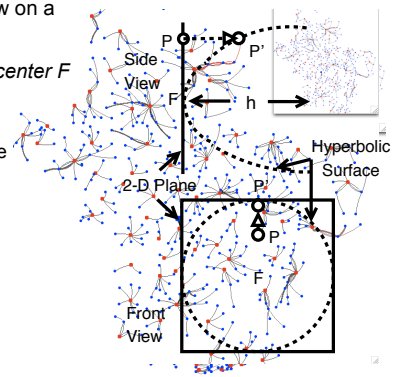
- Point of interest on focal center F

- Other points P

- on the hyperbolic surface
- towards the edge
- oriented from F

- Number of contexts at P

- distance from F
- height h of the hyperbola



★ T. Munzner. Interactive Visualization of Large Graphs and Networks. PhD thesis, Stanford University, June 2000.



14

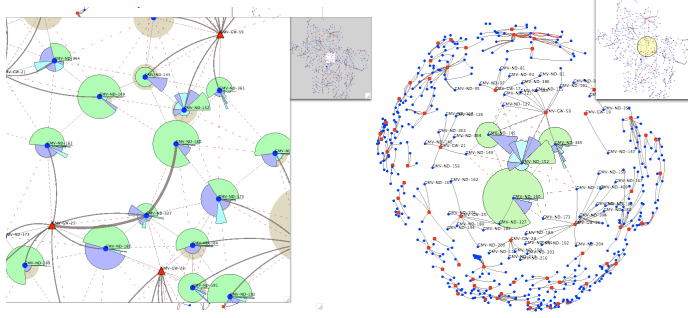
Views trade-off

- Planar view

- Preserves geographic location and orientation of nodes

- Hyperbolic view

- Preserves global view and automatically adjusts contexts



15

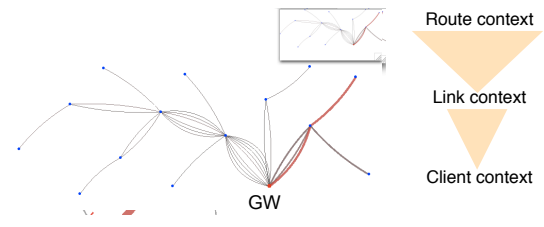
SCUBA on the UCSB MeshNet

- UCSB MeshNet

- 15 nodes (14 repeaters and 1 gateway) on three floors
- Metrics from each node stored in a SQL database
- SCUBA reads metrics from the database

- Problem diagnosis

- Artificial problem client introduced



16

Conclusions

- As networks grow larger, diagnosis becomes harder

- Good visualization tools are important
- Research on key metrics and visualization is necessary

- Scuba is a diagnostic framework

- Metrics organization and interaction with visuals
- Eases diagnosis

- Future of large-scale complex metro networks

- Auto-diagnostic tools and protocols will become very useful
- Scuba is a means of diagnosis as well as planning



17

Future work

- Additional dimensions

- Time - to diagnose temporal problems such as flash-crowds
- 3D Scuba - to use the height as another information descriptor

- SCUBA and the collection of metrics

- Focus-and-context used to control when/which metrics are collected

- Qualitative study of SCUBA usability

- How useful is SCUBA in a variety of scenarios?

- Auto-focus on problems

- Use of thresholds and temporal changes to self-identify problems

- Quantitative study for speed and accuracy of diagnosis



18

Questions?

- SCUBA: Focus and Context for Mesh Health Diagnosis
 - Contact: amitj@cs.ucsb.edu or mock@cs.ucsb.edu
- Video demo of SCUBA on
 - <http://moment.cs.ucsb.edu/conan/scuba>
- 3D version of SCUBA and code
 - <http://cs.ucsb.edu/~mock/netvisual/for290i/>

