Scientific Data Processing on Mobile Devices

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6 August 2015
Smartphones for Scientific Data?

Powerful multi-core computers with many sensors are nearly ubiquitous [1].

Mascharka, Pankratius (MIT Haystack)

Smartphone Data Processing

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- Nearly ubiquitous [1]
What Mobile Devices Offer

Ubiquity allows global distributed system

Global sensor network

Data transfer from the field to scientists

Pre-processing, visualization, and validation in the field

This research: configurable mobile pipeline for scientific data

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Ionospheric total electron content (TEC)
Global sensor network for monitoring TEC
Ionospheric Total Electron Content

- Insight into solar and terrestrial processes
  - Coronal mass ejections
  - Solar winds
  - Earthquakes [2]
  - Nuclear detonations [3]
  - Atmospheric coupling - everything [4]
1. Parsing
2. Collect Data
3. Compute Phase Difference
4. Get Satellite Time Series
5. Processing
6. Compute Differential Range
7. Compute Phase Shift
8. Remove Satellite Bias
9. Calculate and Remove Receiver Bias
10. Apply Mapping Function
11. Compute Elevation Angle
12. Find Closest Ephemeris
13. Visualization
14. Upload Data
- Phase = L1-L2
- Difference of 2 pseudorange values
Data

- Phase = L1-L2
- Difference of 2 pseudorange values
Data

- Phase = L1-L2
- Difference of 2 pseudorange values
- Shift phase to differential range
- Compute satellite position
- Calculate angle of elevation
- Apply mapping function
Data

- Collected outside Haystack using CASES receiver
- 1,018,799 points at 93,575 times
- Data collected every second for 26 hours starting midnight May 18
<table>
<thead>
<tr>
<th>Device</th>
<th>Clock (GHz)</th>
<th># Cores</th>
<th>RAM (GB)</th>
<th>Android Build</th>
<th>Runtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moto X Bionic</td>
<td>2.5</td>
<td>4</td>
<td>2</td>
<td>5.1</td>
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<td>4</td>
<td>16</td>
<td>N/A</td>
<td>OpenJDK 8</td>
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</tbody>
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### Results - May 18 (1 million points)

<table>
<thead>
<tr>
<th>Device</th>
<th>Runtime (s)</th>
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<th>Pause Time (s)</th>
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<tr>
<td>Razr i</td>
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<td>W530</td>
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</tr>
</tbody>
</table>
Data Validation

- Compared against Bill Rideout’s Python TEC module [6]
- Data collected by UNAVCO in Atka, Alaska
Conclusions

- Mobile devices feasible and useful for scientific data
- Reusable pipeline for scientific data transfer, processing, visualization
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- UNAVCO for loans of dual-frequency GPS receivers
- Intel for loans of smartphones
- Haystack


Questions