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Building Capable, Energy-Efficient, Flexible Visualization and Sensing Clusters from Commodity Tablets

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DroidWall: An Energy-Efficient Video Wall of Android Tablet Computers

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Abstract/Position Stmt.

We propose to build an inexpensive, energy-efficient 4x4 video wall from off-the-shelf 7” Android tablet computers. These tablets will form an innovative computational cluster along the three dimensions of video display, central and graphics processing units (CPU and GPU), and input sensors, thereby forming a whole that is greater and more powerful than the sum of its parts: In particular, their combined display resolution is eight times that of commercially available flat screen monitors at roughly the same cost.

Communication: Skeenzone

To enable communication among our tablets, we have built our application on top of the Skeenzone middleware for distributed mobile applications:
http://code.google.com/p/skeenzone

Programing Language

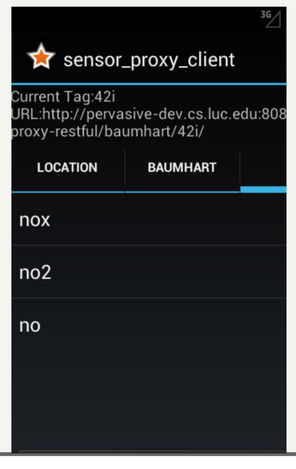
What is Scala?

Why Scala for Android development?

- statically typed
- runs on Java Virtual Machine
- emerging as a development option for building Google Android applications
- hybrid object-oriented/functional language
- concise (up to a factor of ten less code compared to Java)
- Scala is faster in some cases

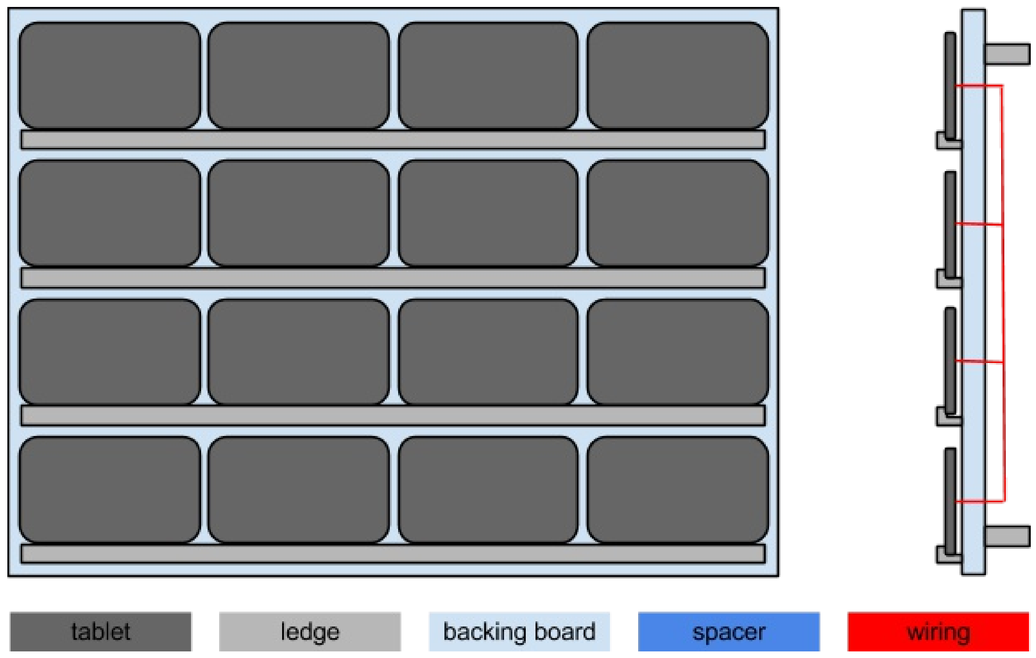
Google has published a paper comparing the performance of four programming languages, C++, its own language Go, Java and Scala. Their conclusion is: Scala provides the most concise notation and best constructs for managing code complexity, and the second-best performance after C++.

Benchmark	Time[Sec]	Factor
C++ Opt	23	1.0x
Java 64-bit	134	8.6x
Java 32-bit	290	12.6x
Scala	82	3.7x



DroidWall

The tablets run the open-source Android operating system, which allows us to install arbitrary custom software. As a result, the proposed wall amounts to a testbed that supports an unprecedented degree of experimentation. Given that each tablet is equipped with a touch screen and various environmental sensors, the wall’s technical capabilities form a “trilogy” of visualization, sensing, and control.



Layout

- Comprises 16 tablets (4x4) connected through a rack which provides energy and support for those tablets.
- Intended to act like a video wall.
- Dynamically reconfigurable as needed.

Setting Tablet Orientation

How do we determine the tablets orientation? It's up to the programmer! Using the strategy pattern, it's possible to elegantly add different kinds of oritentation logic.

```
public void setOrientation(int orientation){
  switch(orientation){
    case Constants.HORIZONTAL:
      this.orientation = new Horizontal(); break;
    case Constants.FOUR_BY_FOUR:
      this.orientation = new FourByFour(); break;
  }
  recalculateMeasures();
}
```

```
// domain model for sensor aggregation web service
val network: Tree[Resource] =
  Location("luc").node(
    Location("lsc").node(
      Location("cuneo").node(
        (new Device(name = "42i", id = "...", address = "...:9501")).node(
          ModbusSetting(name = "unit", offset = 3).node(
            SettingValue(name = "false", value = "ppb").leaf,
            SettingValue(name = "true", value = "ug/m3").leaf
          ),
          Measurement("no").node(
            Reading(name = "current", offset = 0).leaf,
            Reading(name = "min", offset = 10).leaf,
            Reading(name = "max", offset = 20).leaf
          ),
          ...
```

```
class HomeActivity with TypedActivity { // Scala (no casts)

  override def onCreate(savedState: Bundle) {
    super.onCreate(savedState)
    setContentView(R.layout.home)

    val usernameEditText = findView(TR.usernameEditText)
    val passwordEditText = findView(TR.passwordEditText)
    val loginButton = findView(TR.loginButton)

    loginButton.setOnClickListener(new View.OnClickListener() {
      override def onClickListener(View view)  {
        startActivity(new Intent(HomeActivity.this, classOf[NextActivity]))
      }
    })
  }
}
```

```
public class HomeActivity extends Activity { // Java (with casts)

  private EditText usernameEditText;
  private EditText passwordEditText;
  private Button   loginButton;

  public void onCreate(Bundle savedState)  {
    super.onCreate(savedState);
    setContentView(R.layout.home);

    usernameEditText = (EditText) findViewById(R.id.usernameEditText);
    passwordEditText = (EditText) findViewById(R.id.passwordEditText);
    loginButton = (Button) findViewById(R.id.loginButton);

    loginButton.setOnClickListener(new View.OnClickListener() {
      public void onClickListener(View view)  {
        // do some validation stuff
        startActivity(new Intent(HomeActivity.this, NextActivity.class));
      }
    });
  }
}
```

Use Cases

Numerous applications are imaginable!

- environmental and security monitoring
- exploring a three-dimensional molecule
- teaching the color space to art students
- visualizing relationships among versions of a text
- calculating and visualizing the energy footprint of an individual or group

These initial ideas will tie in with a range of research questions in both technical and application domains.

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Showing, touching, sensing, controlling

Like TVs combined to show a game, DroidWall will work in the same way. However, in addition to showing content, it allows to touch and control the content displaying on tablet screens.