RRDtool

RRDtool `\aHr-aHr-´deE-t:ul\n`
[E, fr. round robin database tool]
:a system to store and display time-series data (i.e. utilized bandwidth, machine-room temperature, server load average). R. stores the data in a very compact way so that it will not expand over time, and presents it in useful graphs.

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Contents

- The Results
- The roots of RRDtool
- Design
- Implementation
- Programming with RRDtool
- Pre-Packaged solutions
- Future Work

Exhibit A

Visualization of Data collected with CoralReef package, created with RRDtool.

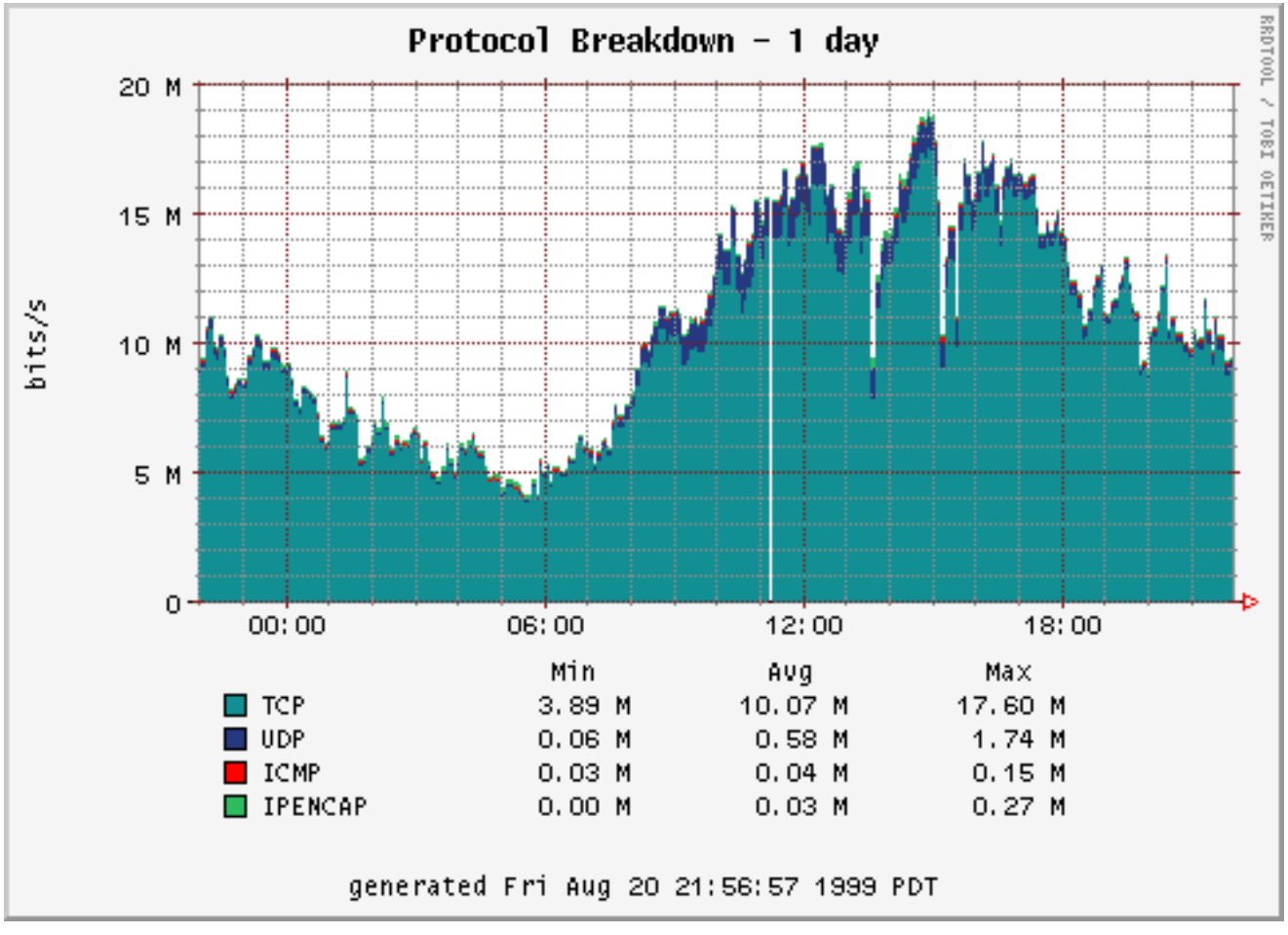
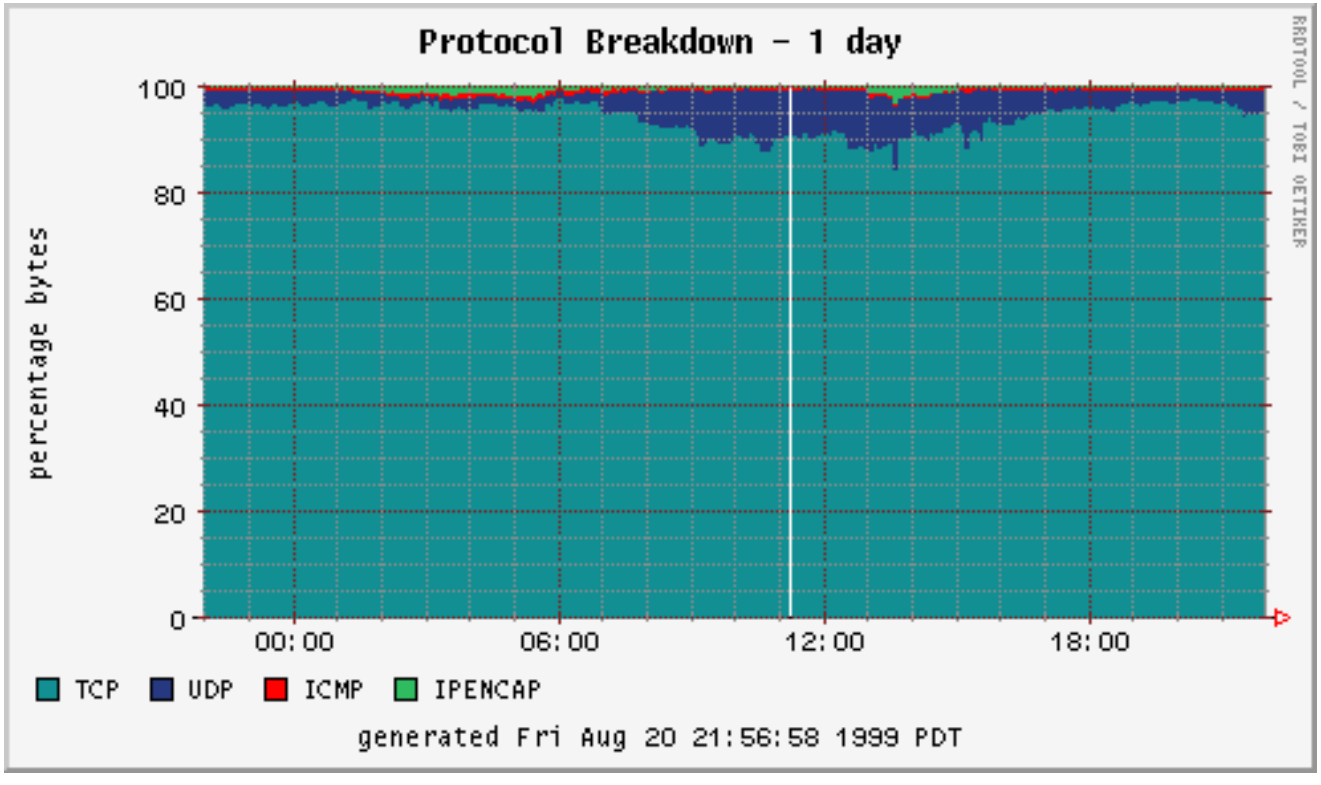


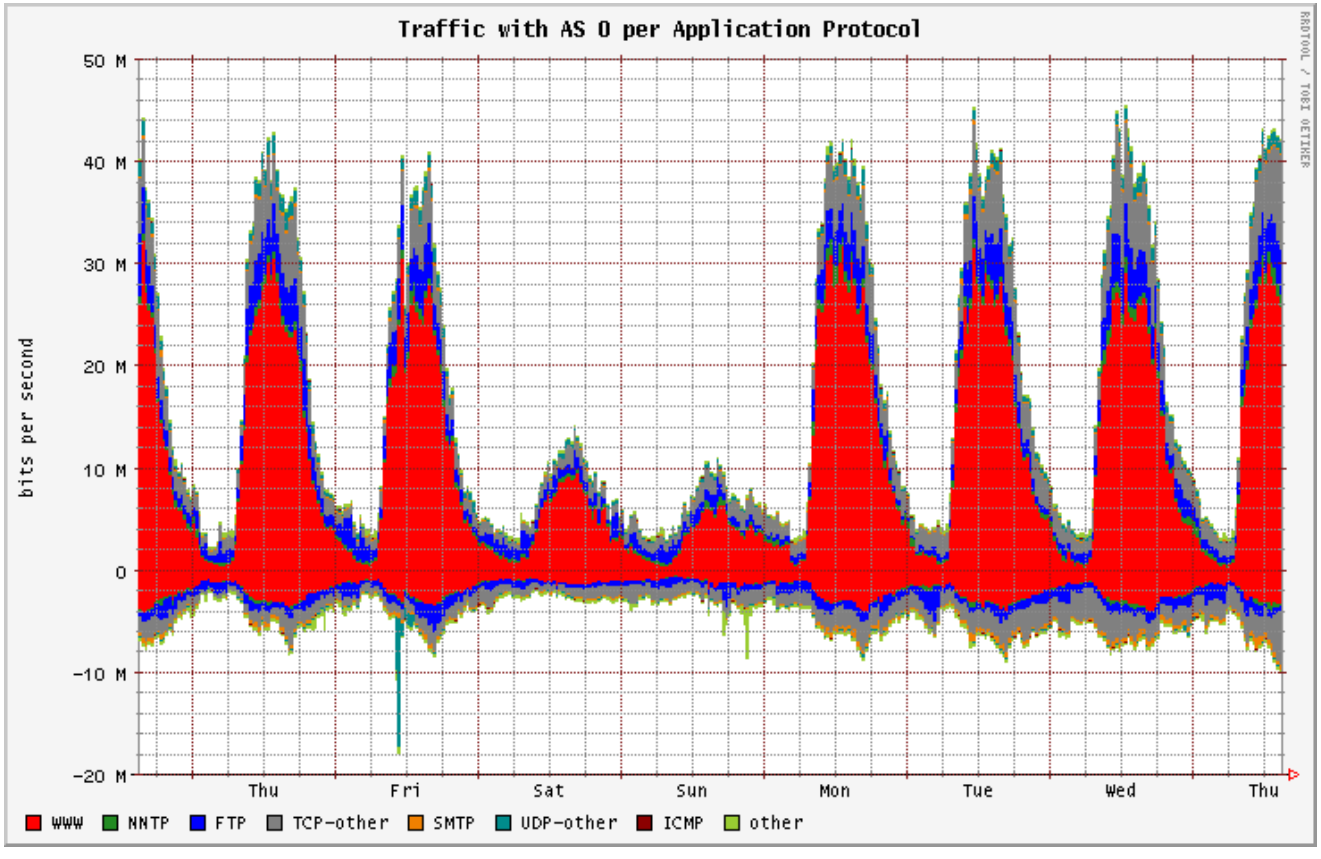
Exhibit B

The same data but normalized to 100%, visualizing protocol distribution.



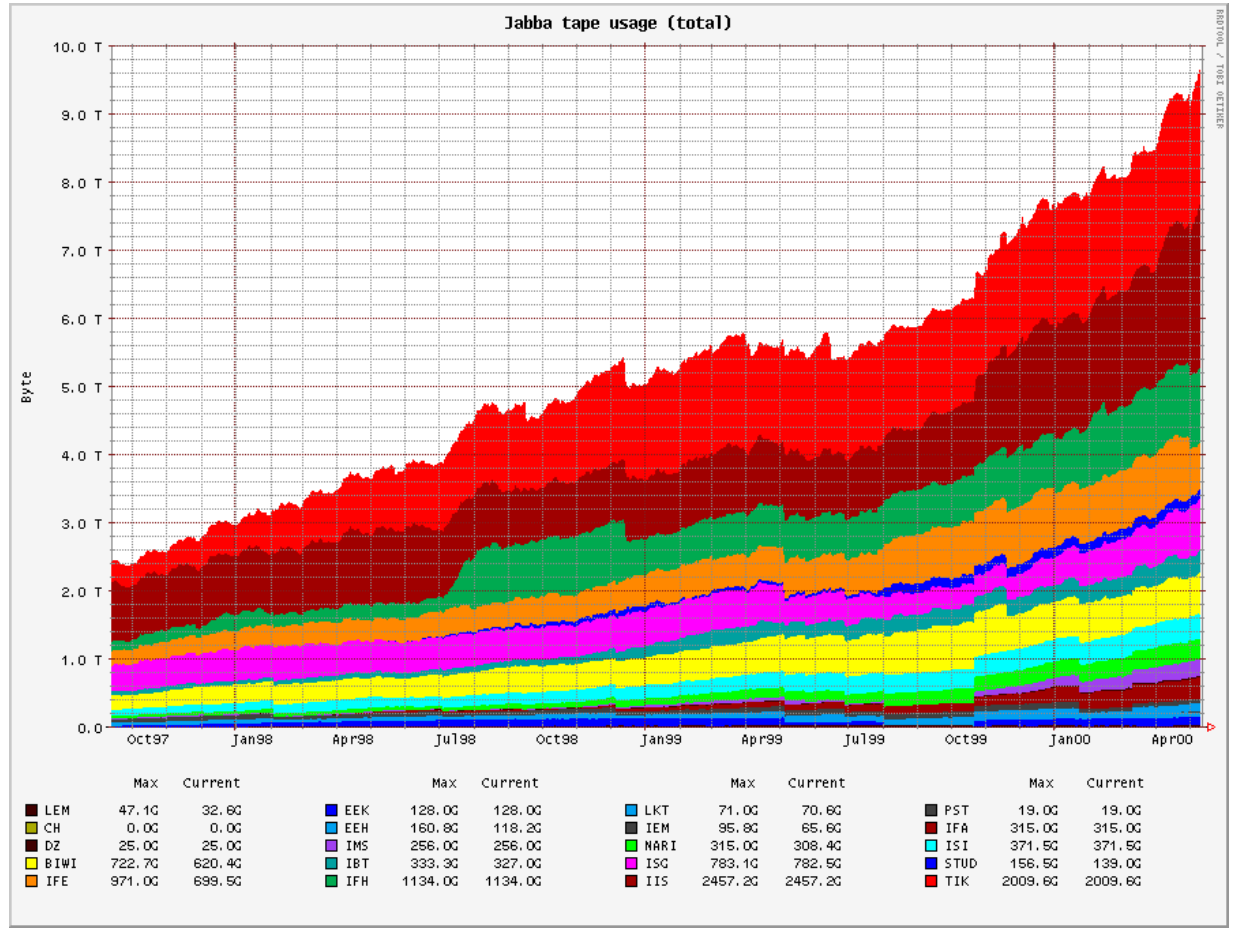
...and just in case: `http://www.caida.org/tools/measurement/coralree`

Exhibit C



...http://www.switch.ch/lan/stat/fluxoscope/

Exhibit D



...http://jabba.ethz.ch/

MRTG - the roots of RRDtool

- 1995 creation of MRTG for a small site
- constant size log files
- growing popularity and thus many patches render code base difficult to maintain
- performance problems in large installations
- lack of flexibility: only two values in graph, integer log format, 5 minute interval, no concept of ’the unknown’

RRDtool Design

Take the **Logging** and **Graphing** from MRTG and make it Faster, Sliker, Better.

- end of 1997 start of RRDtool design
- full documentation
- floating point math
- *unknown* representation as “Not a Number”
- round robin logging for better performance
- flexible and powerful graphing

RRDtool Implementation

The following slides will talk about the implementation of RRDtool.

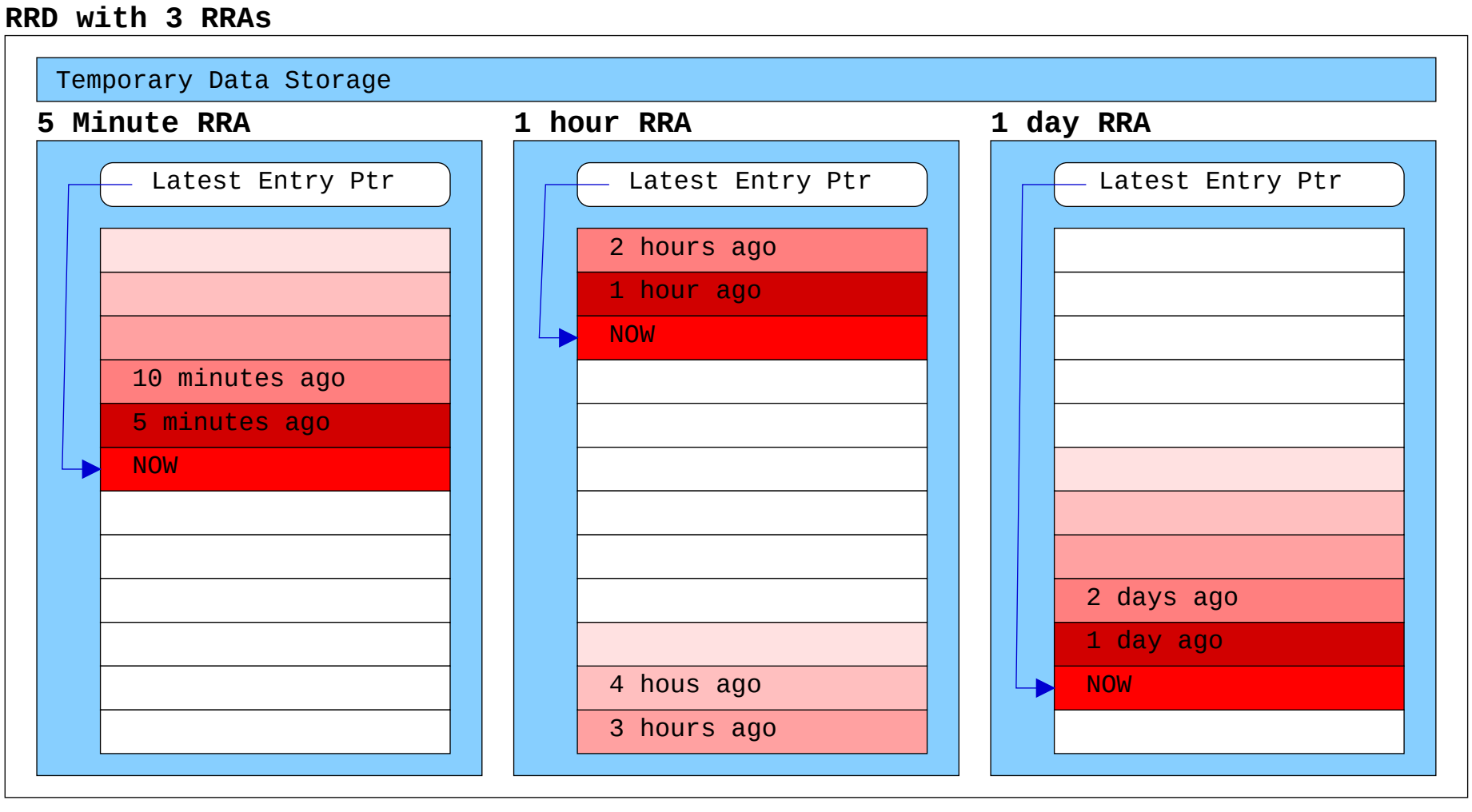
- how RRDtool logging works
- how to create graphs
- general points on the RRDtool syntax
- methods for accessing RRDtool from within your applications

RRDtool Logging

- round robin logging results in minimal data transfer
- fixed resolution logging with random data arrival
- storage of data at different resolutions in parallel
- on-the-fly data consolidation

The next slides will explain these topics in more detail so hang on!

Round Robin Storage



Database Setup

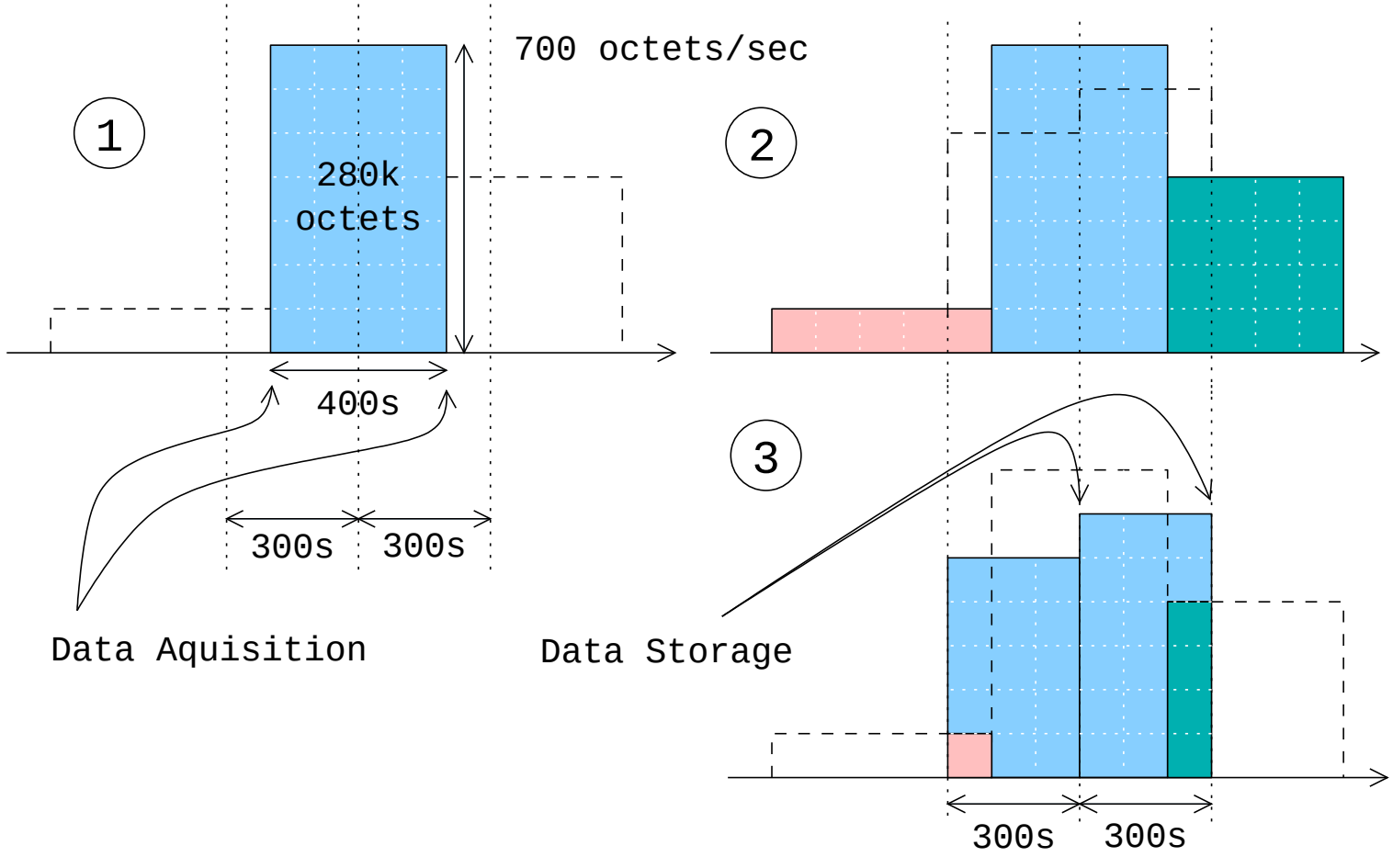
Definition of an RRD Date Source (DS). The definition determines how the data-binning is performed:

DS:*name*:**COUNTER**|**GAUGE**|**ABSOLUTE**:*heart-beat*:*min*:*max*

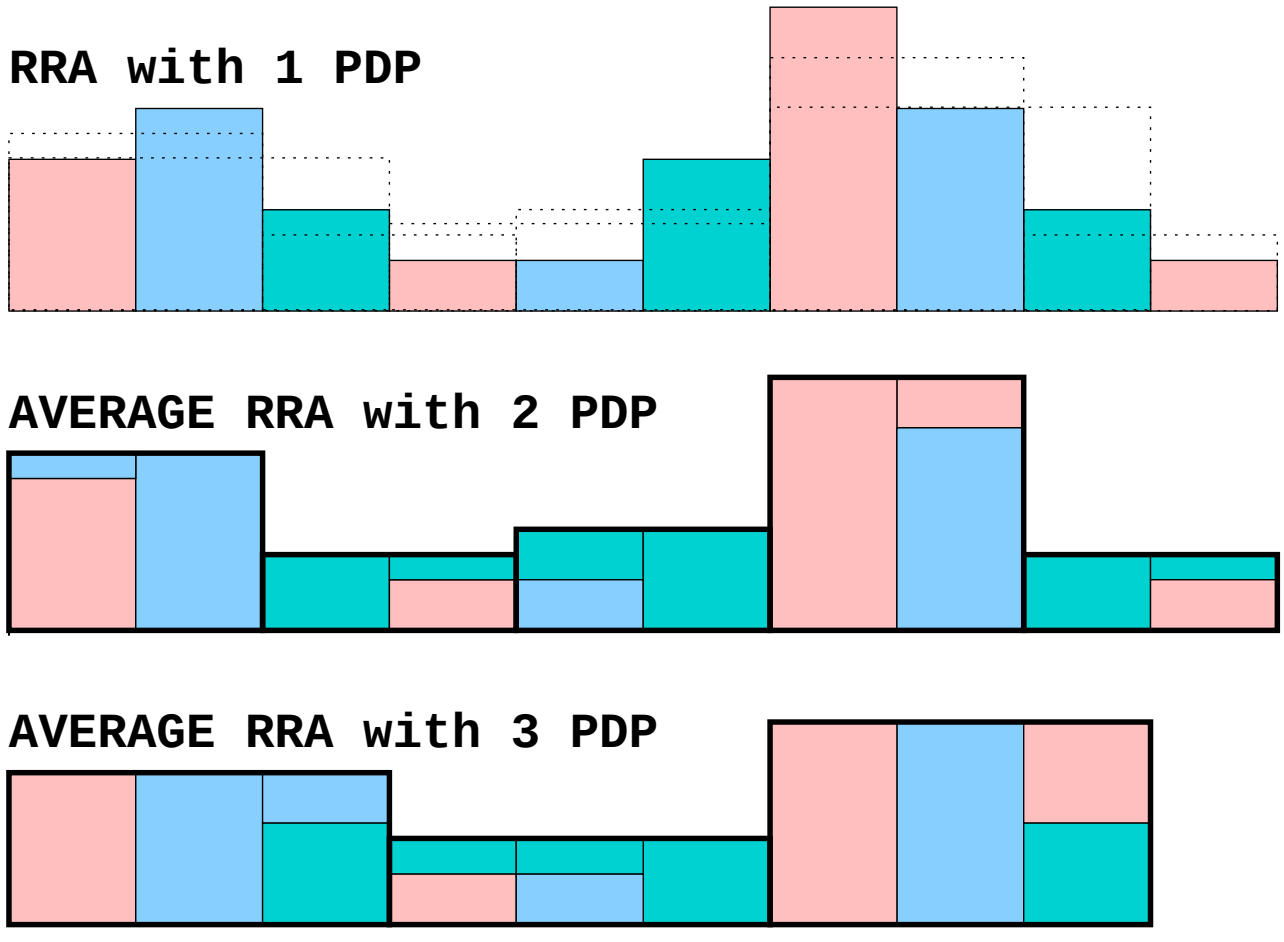
Definition of a Round Robin Archive (RRA) which receives its data by aggregating a *number* of re-binned input values using a *Consolitation Function* (CF). If less than *part* of the input values are known, the result will be *UNKNOWN*. The results are stored in a rotary buffer of *length*:

RRA:**AVERAGE**|**MIN**|**MAX**:*part*:*number*:*length*

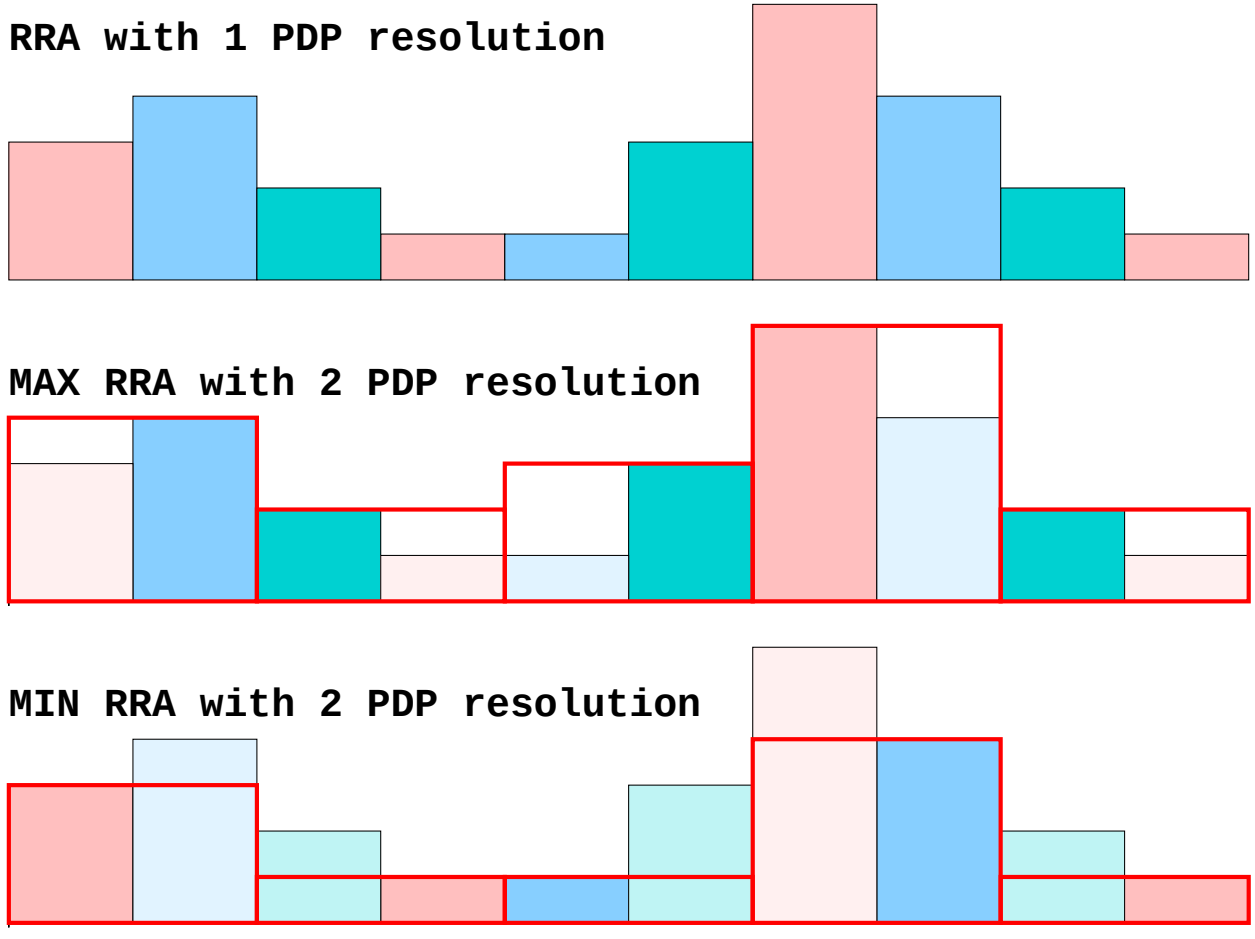
Data Input “Data Re-Binning”



Data Consolidation



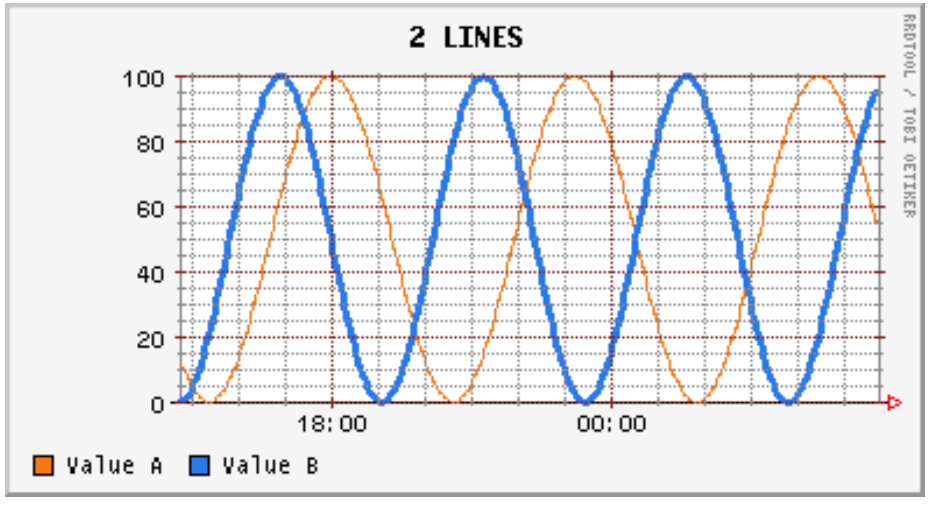
Data Consolidation Methods

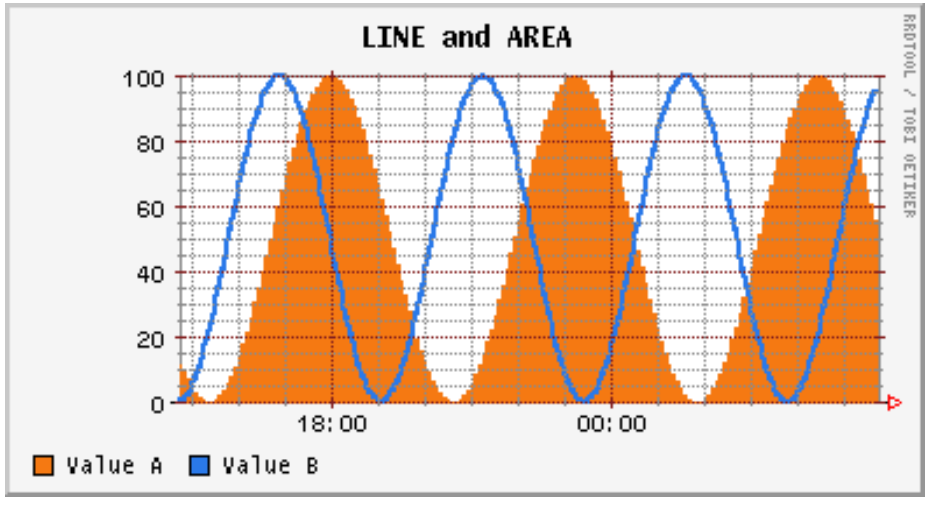


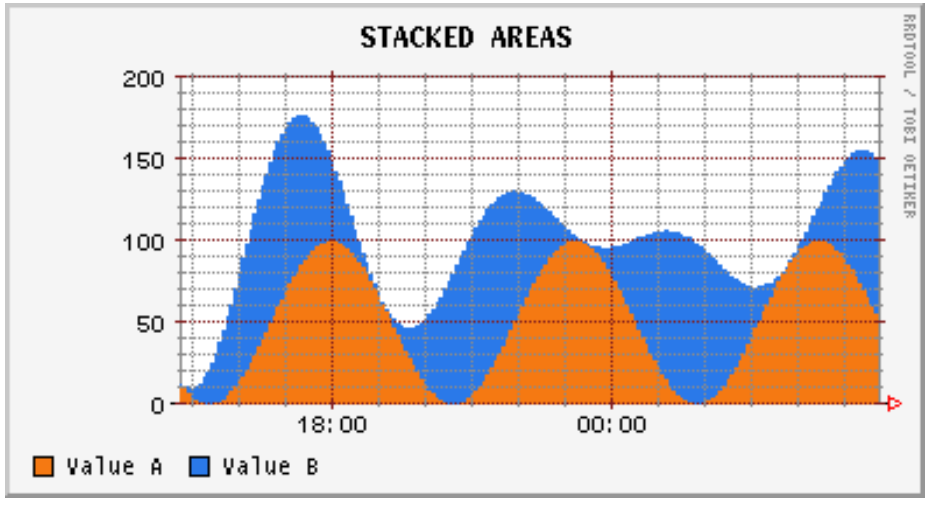
Graphing

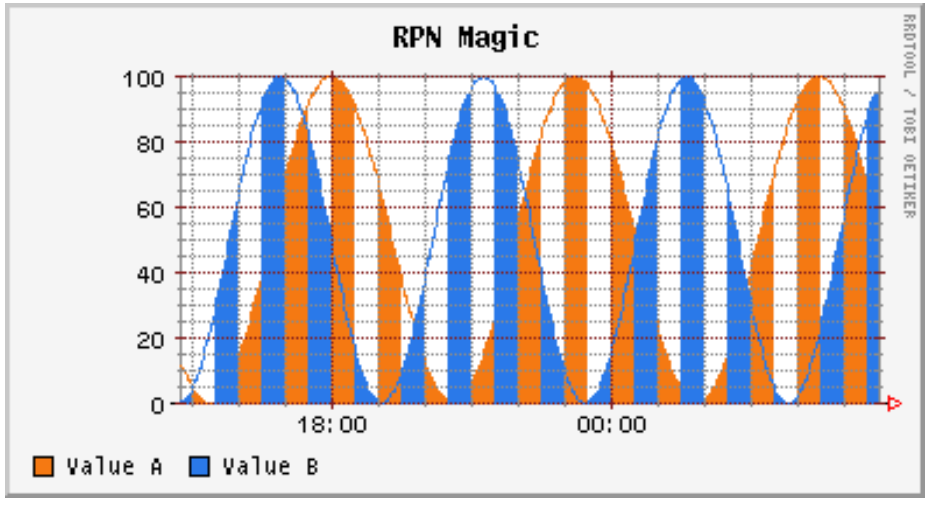
- use data from any number of RRDs
- line, area and stack charts
- perform powerful RPN math on data before graphing it

Chart Type Demo









RPN math

Pick a data source (octet counter):

```
DEF:a=file.rrd:incoming:AVERAGE
```

Modify the data: (People want to see bits while we get Octets from the router)

```
CDEF:b=a,8,*
```

Plot the data: (#ff0000 is the hex-triple representation for the color red)

```
AREA:b#ff0000:Incoming
```

RRDtool Syntax

- many simple functions
- each one does its own argument evaluation
- functions do not exit or output
- caller has to deal with return values
- full documentation is available as pod, man, txt and html

```
rrdtool function arguments ...
```

Using RRDtool

- stand-alone: command line or pipe
- perl-module: accessing stand-alone or using a shared module
- RRDtool can be compiled as a shared library
- bindings for other languages developed by contributors
- rrdcgi for web pages

Regardless of the language you are using RRDtool from, the syntax is always the same apart from requirements of the language.

RRDtool functions I

Currently RRDtool has the following functions

create sets up a new Round Robin Database (RRD).

update stores new data values into an RRD.

graph creates a graph from data stored in one or several RRDs. Apart from generating graphs, data can also be extracted to stdout.

dump dumps the contents of an RRD in plain ASCII. In connection with restore you can use it to transport an RRD from one architecture to another.

continues on next slide . . .

RRDtool functions II

restore restores an RRD from XML format to a binary RRD.

fetch gets data for a certain time period from an RRD. The graph function uses fetch to retrieve its data from an RRD

tune alters the configuration of an RRD

last finds last update time of an RRD

rrdresize changes the size of individual RRAs ... Dangerous!

Creating an RRDtool database

```
rrdtool create demo.rrd
--step=300
DS:in:COUNTER:600:0:1.25e6
DS:out:COUNTER:600:0:1.25e6
RRA:AVERAGE:0.5:1:288
RRA:AVERAGE:0.5:12:168
RRA:MIN:0.5:12:168
RRA:MAX:0.5:12:168
```

by default, RRDtool will align incoming data into 5 minute bins

therefore this would not be necessary

max update interval 600s

min val 0, max val 1.25MB

5 minute average for a day

1 hour average for a week

1 hour minima for a week

1 hour maxima for a week

Updating an RRDtool database

```
rrdtool update demo.rrd
--template in:out
N:11222:1
```

defines the order of values in the next argument

‘N’=now could be sec since 1970

Generating a Graph

```
rrdtool graph ouput.png
--imgformat=PNG
--lower-limit=0
DEF:a=demo.rrd:in:AVERAGE

DEF:b=demo.rrd:in:MAX
AREA:a#00ff00:Incoming
LINE1:b#ff0000:"Max Incoming"
```

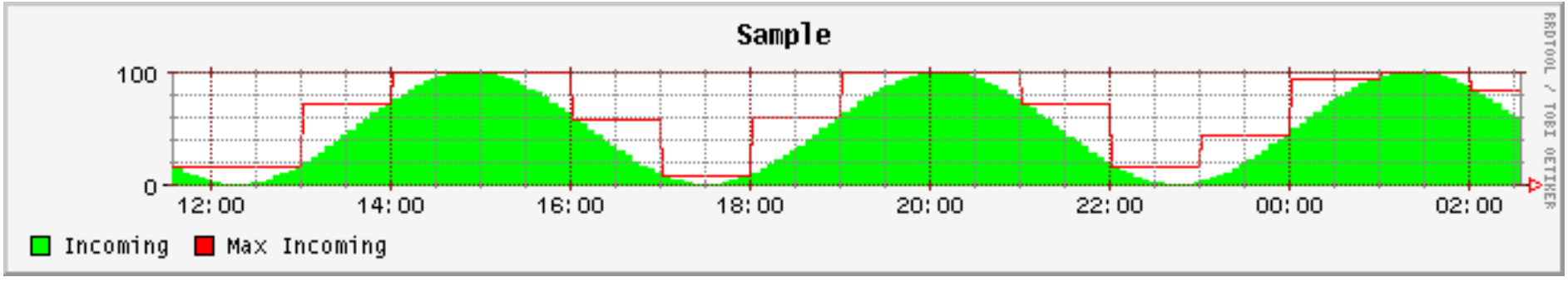
makes the y axis start at 0

'a' gets data from the first RRA matching the resolution of the graph and covering the required time-span

get data from an RRA with MAX consolidation

a green AREA

a thin red line



Points to keep in mind

- RRDtool will make sure no garbage data goes into an RRD database. But in order to do so it must know what is sensible. Always specify MIN and MAX boundaries when setting up a new RRD.
- Use version numbers in the `use` statement for the RRD's perl module. This ensures you load the version of the module you expect to load. Module versions are in sync with RRDtool versions:

  x.y.z = x.yyzzz1 (eg. 1.0.10 = 1.000101)

- Use `--lower-limit` if you want to make sure that the graph starts at 0.

RRDcgi

Creating graphs is quite expensive, so why not do it on demand.

```
#!/usr/local/rrdtool-1.0.10/bin/rrdcgi
<HTML>
<HEAD><TITLE>RRD CGI Demo</TITLE></HEAD>
<BODY>
<H1>Demo Graph</H1>

<P><RRD::GRAPH
  ouput.png --imgformat=PNG   --lower-limit=0 --lazy
  DEF:a=demo.rrd:in:AVERAGE DEF:b=demo.rrd:in:MAX
  AREA:a#00ff00:Incoming    LINE1:b#ff0000:"Max In..."
></P>

</BODY></HTML>
```

RRDtool Frontends

Why write your own Frontend when you can use someone else's:

- MRTG
- Cricket
- Orca
- SmokePing
- and *many* more

Read all about it on
`http://people.ee.ethz.ch/~oetiker/webtools/rrdtool/rrdworld`

Future Work on RRDtool

Version numbers will follow linux concept: Even sub-versions for stable code, odd numbers for development versions.
New Features of RRDtool 1.1.x:

- anti aliased, zoomable graphs with TrueType font support
- alternate graphics formats EPS, PDF, SVG (no more GIF)
- new data analysis functions in the graph module to support 95 percentile analysis and similar tasks.
- holt-winters aberrant behaviour detection

Thanks!

http://people.ee.ethz.ch/~oetiker/webtools/rrdtool