

Od Arduina k Linuxu

Operační systémy reálného času
(RTOS – Real Time Operating Systems)

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Solar Monitor s.r.o.

Rozdělení systémů podle užití a složitosti

- **Holá deska**

(bare board)

- **Registrace smyček**

(Hardware)

- **Arduino**

(single thread, setup, loop)

- **RTOS**

(uC/OS-II, III, Nut/OS, FreeRTOS, Zephyr, uTasker, Contiki)

- **Linux / Windows**

Cena, rychlost vývoje, spolehlivost

- **Holá deska (bare board)**
- Vše programuji sám
- Výrobce čipu dodává SDK
- Tool pro nastavení pinů a hodin
(NXP MCU Xpresso, ST Cube MX)
- API pro periferie platformy
(I2C, SPI, EEPROM, flash, časovače)

- **Registrace smyček**
- Zjednodušení kódu,
- hlavní smyčka rozdělena
- Vlastně stále není OS
- Pouze u cpu s velmi malou pamětí

- **Arduino**

- 8-bit AVR RISC
- 32-bit STM32x, NXP Kinetis MK6x (Teensy)
- setup, loop
- Knihovny, hotově x obtížněji se píše
- Horší ladění

• **RTOS**

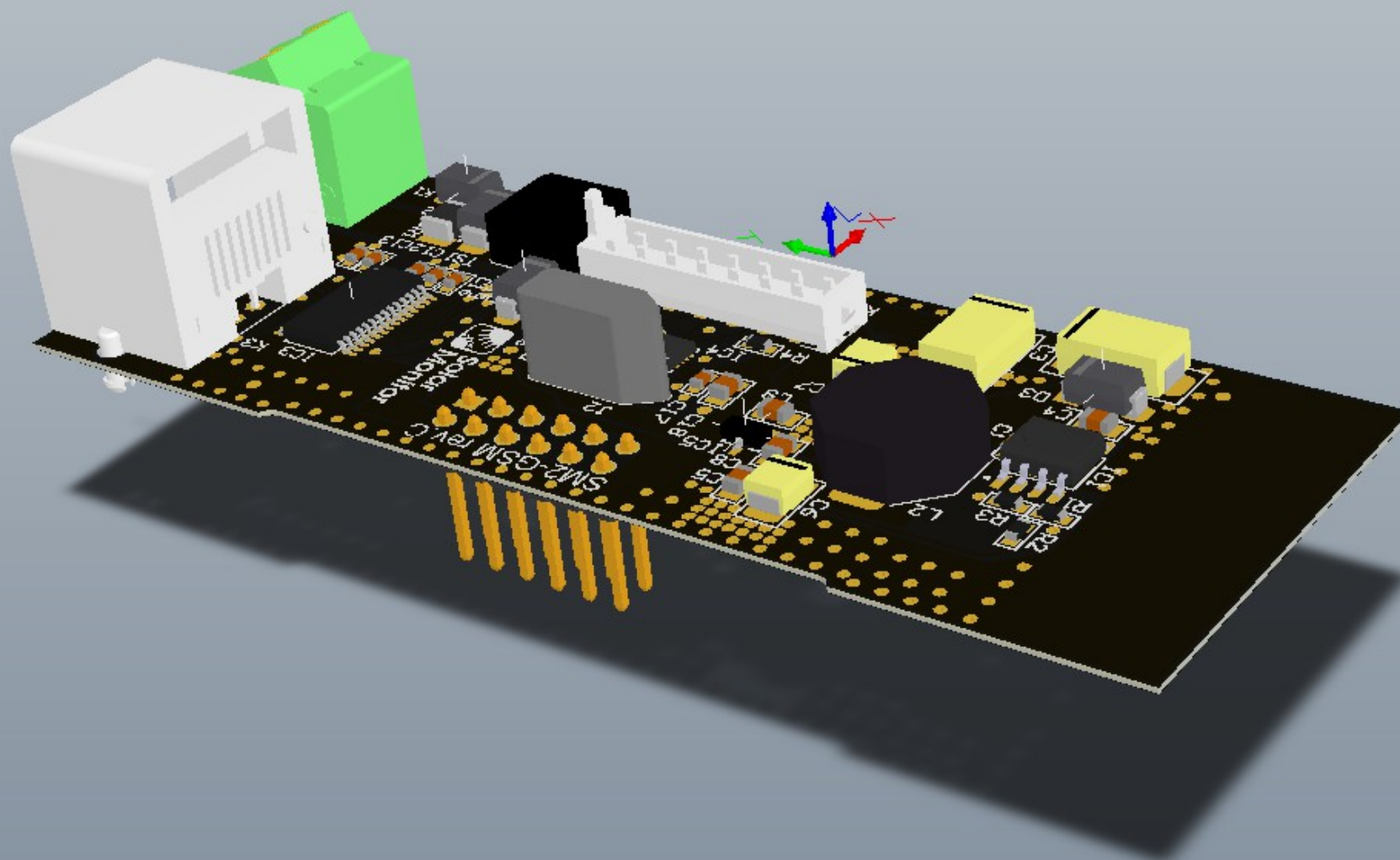
- Komunikace / synchronizace mezi vlákny
- Mutex, semafor, msg, event, priority
- Drivery (periferie, na čipu, bus based)
- File systémy (FAT, flash)
- Protokoly (TCP + aplikační, M2M)
- Crt systém (open, read / write, close)
- Vše slinkuji v 1 image (většinou)

- **Linux**
- MMU (ochrana proti chybám)
- Flexibilita + více služeb x větší nároky na hw
- Bootloader + loader programů (elf)
- Konfigurovatelnost (build systémy)
- Moduly
- Sdílené knihovny
- ...

- **Linux ...**
- Init systém, udev / kdev
- Připojitelnost file systémů (ext2 – 4, NFS, JFFS2, UBI)
- Packages (apt-get) OVPN, Ipsec, Java HMI (Qt)
- Pipes (grep)
- Shell + skripty, terminál (konzole) x ssh
- Http, cgi, cli (shell)
- ...

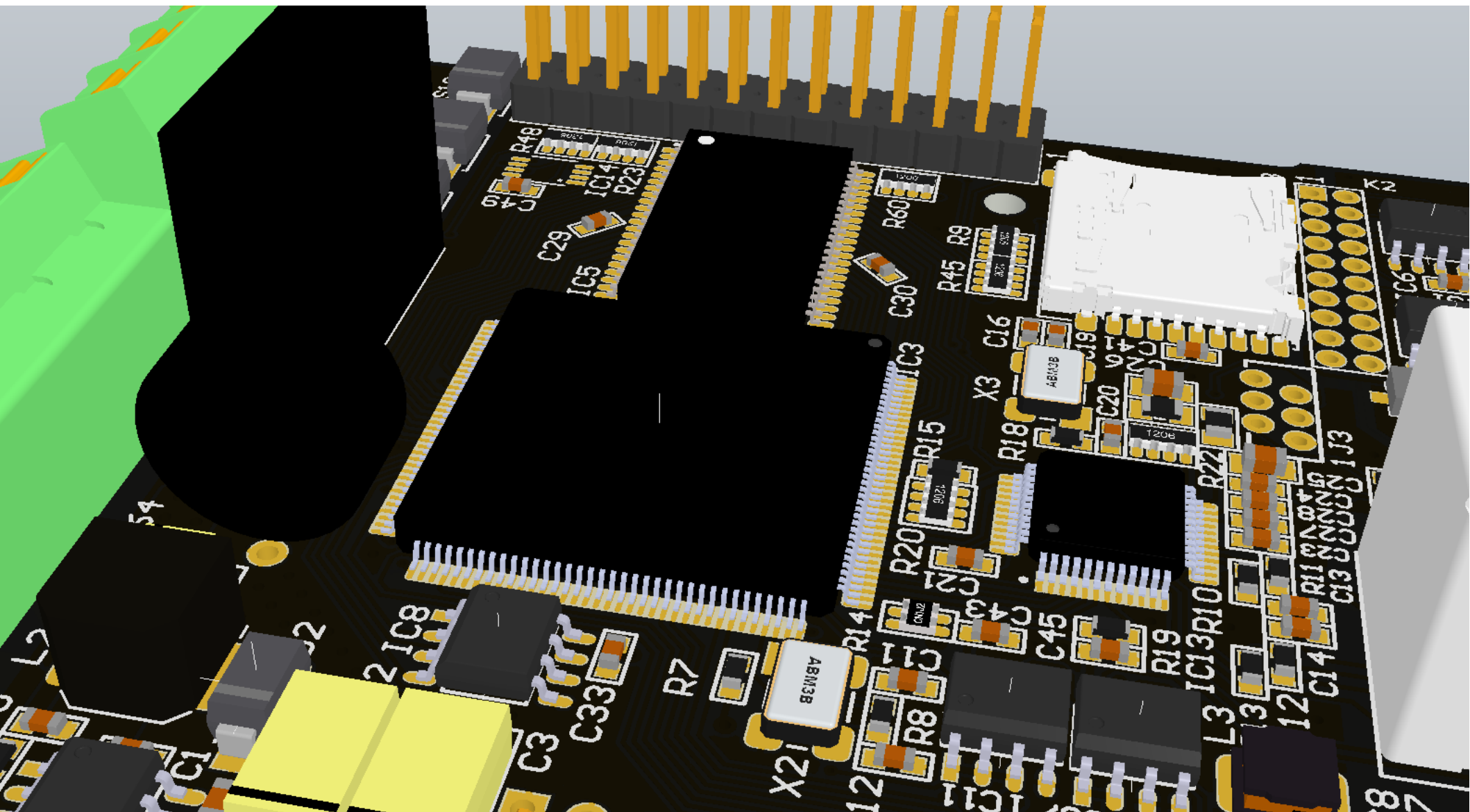
- **Linux ...**
- Bezpečnost firmware
- ARM TrustZone, certifikáty
- Build systems (Yocto, flexbuild, buildroot, LTIB)
- ...

Ukázky řešení - Bare board



- **Bare board**
- Ovládání GPRS modulu DTR signálem
- Implementace stavového automatu
(Podle datasheetu modulu)
- Kinetis® MK02L, Arm® Cortex®-M0+
- 32kB RAM
- Ultra Low Power Mode - 9 μ A @ 250 kHz

Ukázky řešení - RTOS Nut/OS



- **RTOS Nut/OS**
- Energetická gateway pro obnovitelné zdroje
- Datalogger + M2M (SNMP, Modbus Sunspec, SOAP, XML)
- Modulární systém
- Coldfire® MCF52259, M68k @ 48 MHz
- 512kB on chip flash, 512 kB static RAM
- Ethernet 10 / 100 Mb

Webový server SM2-MU: Responzivní design



Setup Wizard Old Design Solar Monitor Portal Wiki

Overview SolarMonitor - Studer Test

Overview

Peaks

LCD Panel

Charts

Alerts

Home > Overview



Inverter(s) Total Produced Energy from inverters



Today Earnings
0.0 kWh **0.0**
Total Earnings

Tracker(s) Total Produced Energy from trackers



Today Earnings
0.0 kWh **0.0**
Total Earnings

Inverters (Hybrid)



Name	State	Mode	Temperature	Grid power (0.2kW)	Power (0.2kW)	Updated
XTH 8000-48V (L1)	✓	Charger	- °C	104.98 W	141.96 W	0s
XTH 8000-48V (L2)	✓	Charger	- °C	151 W	42.99 W	0s
XTH 8000-48V (L3)	✓	Charger	- °C	-20 W	42.99 W	0s

MPP Trackers



Name	State	Mode	Temperature	Arr Power (0kW)	Power (0.1kW)	Updated
VT 80-48V	✓	Night	22 °C	0 W	52 W	0s
VS 70-48V	✓	Night	22 °C	0 W	0 W	0s
VS 120-48V	✓	Night	22 °C	0 W	0 W	0s

Ukázka grafu: normální průběh, odběr přes den

← ↑ → Od 30.07.2018 Do 30.07.2018 **dnes** listopad 2018

Dashboard

Solar Production

Max: 3.00 [kW]
Energy: 25.23 [kWh]

Consumption

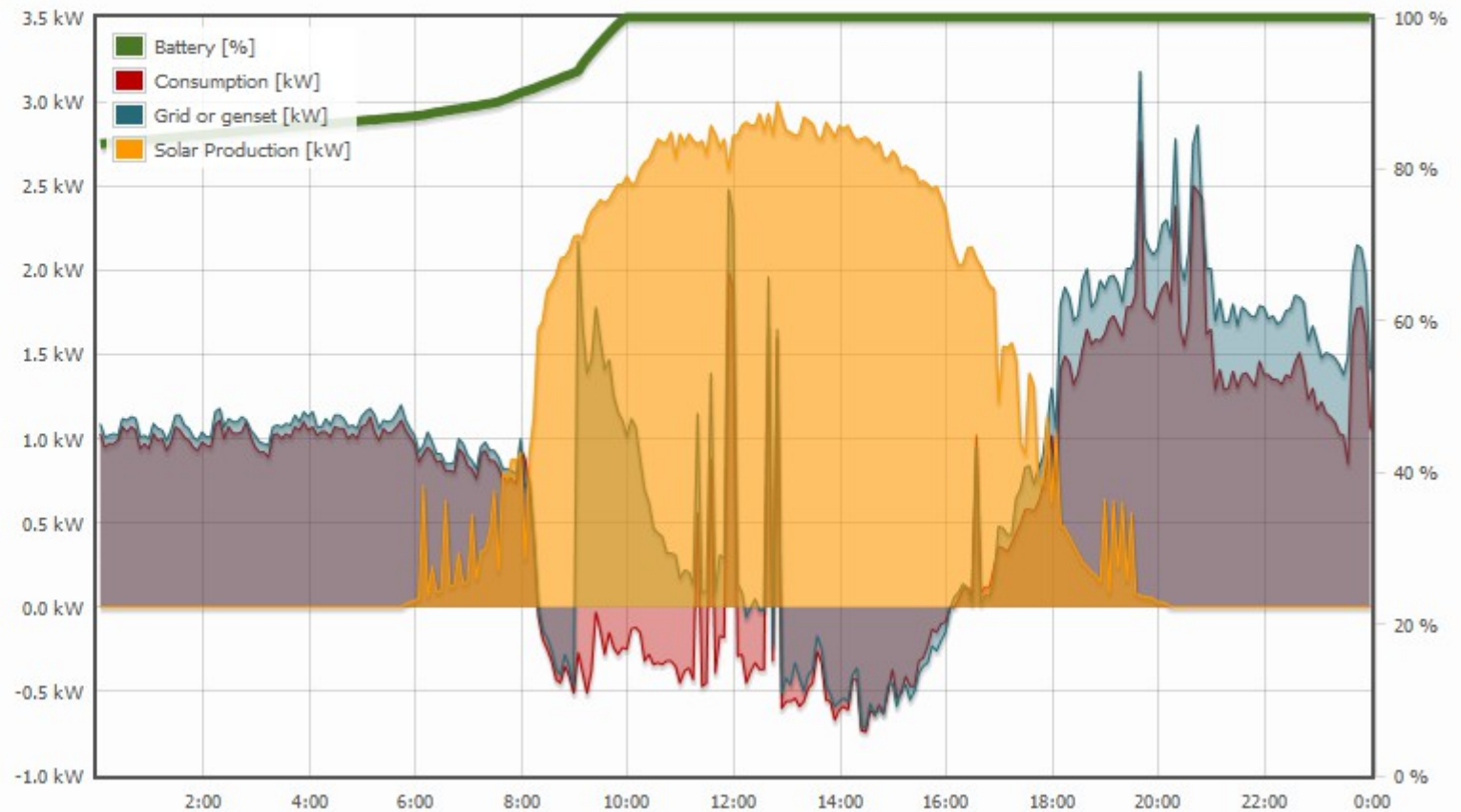
Max: 2.77 [kW]
Energy: 16.04 [kWh]

Grid or genset

Max: 3.18 [kW]
Energy: 22.24 [kWh]

Battery SOC

Max: 100.00 [%]
Min: 83.31 [%]



RTOS - Ukázka seznamu běžících threadů

Nut/OS Threads

HeapAvailable: 167276 runQueue: 80031B48 MWDT: HTTP8

Handle	Name	Priority	Status	Event Queue	Timer	Stack-pointer	td_qnxt	td_qpec	Free Stack	FS mutex	FS Drive	
80051FB4	Logger	40	SLP	80006106	8000DB60	80051F30	0000	0000	1404	0	0	OK
80051988	SpiLog	64	SLP	80006102	0000	80051914	0000	0000	2420	0	0	OK
80050ABC	dash	80	SLP	0000	80056788	80050A0C	0000	0000	1872	999	-1	OK
80050290	rw_value	55	SLP	80005C02	0000	80050220	0000	0000	1936	999	-1	OK
8004FA64	SolarDev	64	SLP	0000	80032CE4	8004FA08	0000	0000	1956	0	0	OK
8004F238	TCP	64	SLP	0000	800288A8	8004F1CC	0000	0000	1940	0	0	OK
8004EA0C	RS232	64	SLP	0000	80032034	8004E7BC	0000	0000	1456	0	0	OK
80040904	RS485	64	SLP	0000	800320CC	800408A0	0000	0000	1948	0	0	OK
800400D8	485_low	50	SLP	8000508E	0000	80040030	0000	0000	856	0	0	OK
8003B078	snmp	48	SLP	8003413E	0000	8003AFA8	0000	0000	3888	999	-1	OK
80033DC4	TelSet	70	SLP	80056C44	0000	80033CD8	0000	0000	1044	0	0	OK
80033898	sntp	64	SLP	80005C14	80034978	800337BC	0000	0000	804	0	0	OK
80032BEC	tcpasm	32	SLP	8000D2E4	80032CC8	80032B50	0000	0000	1892	999	-1	OK
80031B48	httpd9	70	RUN	8000D3C8	0000	80031994	20000504	0000	2124	0	0	OK
800310F4	httpd8	70	SLP	80034258	0000	8003104C	0000	0000	2392	0	0	OK
2000D520	httpd7	70	SLP	80056E44	0000	2000D478	0000	0000	2392	0	0	OK
2000CAF4	httpd6	70	SLP	80033330	0000	2000CA4C	0000	0000	2392	0	0	OK
2000C0C8	httpd5	70	SLP	80056FF4	0000	2000C020	0000	0000	2392	0	0	OK
2000B69C	httpd4	70	SLP	80032F44	0000	2000B5F4	0000	0000	2392	0	0	OK
2000AC70	httpd3	70	SLP	80033480	0000	2000ABC8	0000	0000	2392	0	0	OK
2000A244	httpd2	70	SLP	80057244	0000	2000A19C	0000	0000	2392	0	0	OK
20009818	httpd1	70	SLP	80056DA8	0000	20009770	0000	0000	2392	0	0	OK
20008DEC	httpd0	70	SLP	80032E70	0000	20008D44	0000	0000	2392	0	0	OK
200083C0	udpSetup	64	SLP	80029116	0000	20008314	0000	0000	1108	0	0	OK
20007E94	Portal	64	SLP	80023E3E	80054ADC	20007E24	0000	0000	1936	0	0	OK
20005E54	eth0rx	9	SLP	8000D6C0	80032358	20005DA4	0000	0000	824	999	-1	OK
20005A40	HBus	64	SLP	8002A1B8	8002915C	20005904	0000	0000	1732	0	0	OK
20005214	comlow_h	50	SLP	80005178	0000	2000516C	0000	0000	856	0	0	OK
20004DE8	PwrCtrl	64	SLP	0000	80031EEC	20004D84	0000	0000	1436	0	0	OK
80047B0C	PwrCtrl	64	SLP	0000	80032034	80047B0C	0000	0000	1436	0	0	OK

Ukázka programu pro PLC Foxtrot: čtení dat

```
PROGRAM prgMain
  VAR_INPUT
  END_VAR
  VAR_OUTPUT
  END_VAR
  VAR
    enable : BOOL := 1;
    ip : STRING := '192.168.1.221:502';
    chanCode : UINT := ETH1_uni0;
    tcp : BOOL := TRUE;
    sm : fb_Solarmonitor10;

  END_VAR
  VAR_TEMP
  END_VAR

  sm(enable := enable, ip := ip, chanCode := chanCode, tcp := tcp);

END_PROGRAM
```

SNMP – Castlerock SNMPc: Geografické mapy

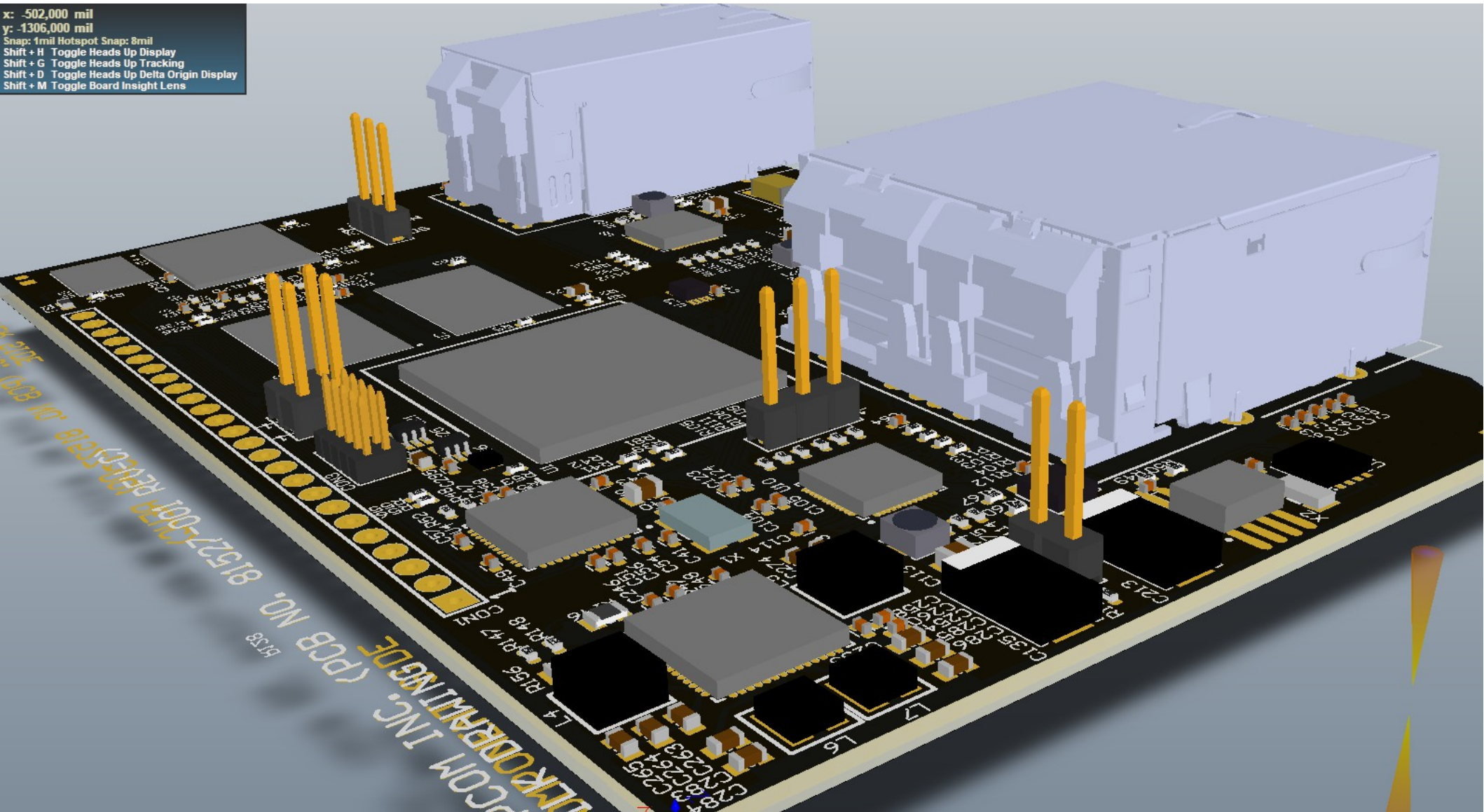
The screenshot displays the SNMPc Management Console interface. On the left, a tree view shows the network hierarchy under 'Root Subnet', including 'Discovered Objects', 'Backbone', 'Coporate', 'Intl', and various regional nodes like 'CRC_HQ', 'Dallas', 'Denver', 'Lansing', 'Miami', and 'NY'. The central panel features a map of the United States with icons for 'CRC_HQ', 'Denver', 'Dallas', 'Lansing', and 'Miami'. A 'Branches' window is overlaid on the map. To the right, a network topology diagram shows a 'Company_WAN' connected to various devices including 'HP_8200', 'WAP_1', 'VoIP_CM', 'Backup', 'Cisco_7200', 'Servers_1', 'App_Server', 'DNS', 'Exchange', and 'UNIX'. The bottom panel shows a log of events with columns for status, date, time, source, and message. The status is consistently 'Normal'. The log entries are:

Status	Date	Time	Source	Message
Normal	09/10/2009	14:15:28	User-PC	Sntp Service Up
Normal	09/10/2009	14:41:16	DNA	Device Responding to Poll
Normal	09/10/2009	15:03:58	San_Jose	Trend Report Agent Connected to Server
Normal	09/10/2009	15:09:51	Florida	Device Responding to Poll
Normal	09/10/2009	15:10:38	Dallas	Device Responding to Poll

The interface also includes a menu bar (File, Edit, View, Insert, Manage, Tools, Config, Window, Help), a toolbar with navigation icons, and a status bar at the bottom with the text 'For Help, press F1' and user information 'localhost Administrator Supervisor'.

Ukázky řešení - Linux

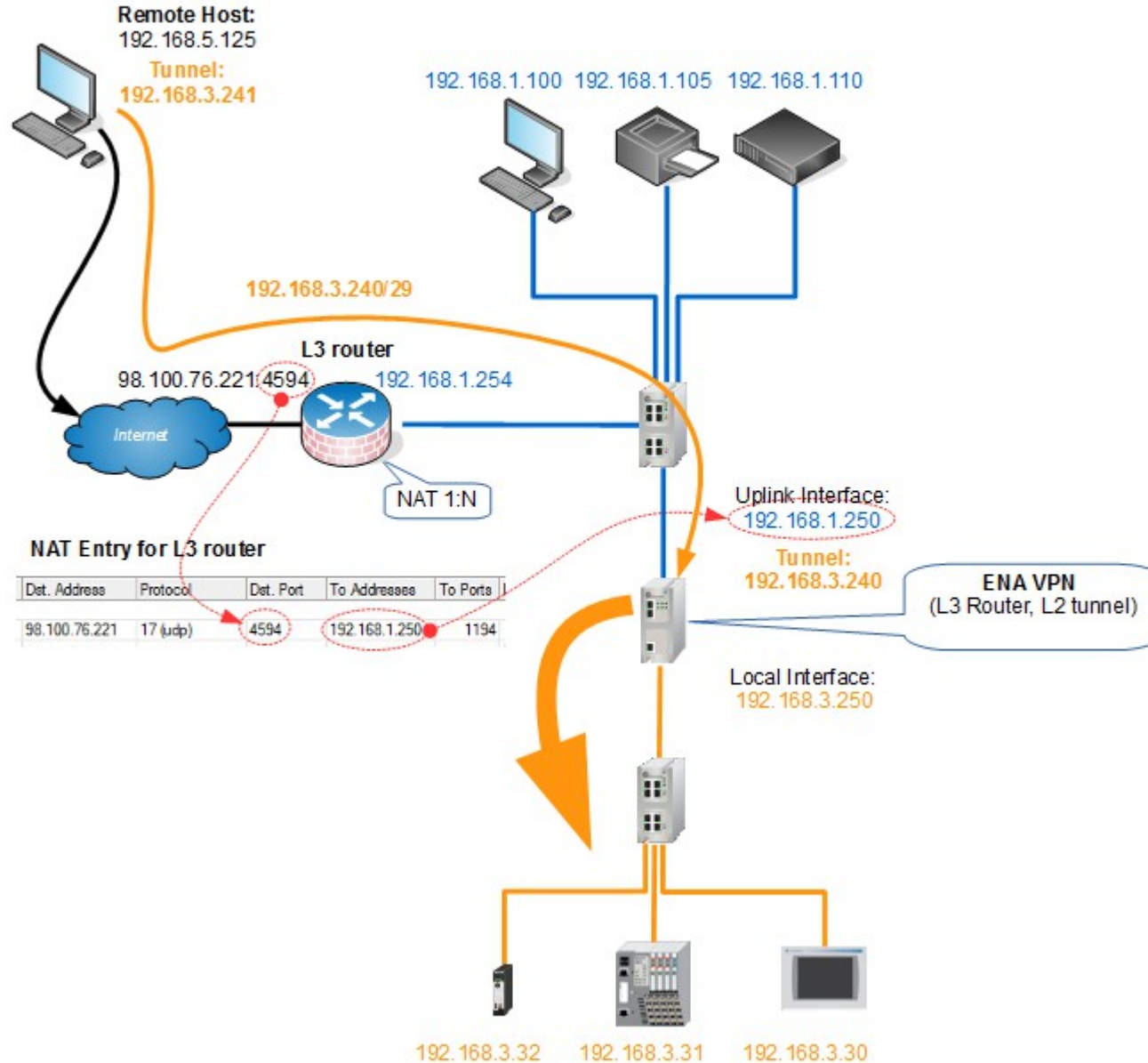
x: -502,000 mil
y: -1306,000 mil
Snap: 1mil Hotspot Snap: 8mil
Shift + H Toggle Heads Up Display
Shift + G Toggle Heads Up Tracking
Shift + D Toggle Heads Up Delta Origin Display
Shift + M Toggle Board Insight Lens



• **Linux**

- Allen-Bradley 9300 – ENA (Ethernet Network Appliance)
- Překlad IP adres včetně broadcastů
- Vyhledání IP zařízení v síti + konfigurace
- OpenVPN + IPsec včetně instalace na PC
- QorIQ® Layerscape 1021A
- 2x Arm® Cortex®-A7 @ 1.2 GHz
- 256 MB NOR flash, 1 GB DDR3L RAM
- 3x Ethernet 10 Mb / 100 Mb / 1 Gb

Ukázky řešení – Linux: schema aplikace



Děkuji za pozornost.

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